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ORIGINAL ARTICLES.

I.—On Some Scandinavian Phyllocarida.

By Prof. T. Rupert Jones, F.R.S., and Dr. Henry Woodward, F.R.S.

(PLATE V.)

SOME Phyllocarida from the Silurian strata of Scandinavia (Sweden and the Island of Gothland) are represented by specimens in the State Museum at Stockholm. Drawings, casts, or the specimens themselves have been shown to us by our friend Professor Gustav Lindström, F.C.G.S., and we have arrived at the following conclusions as to their relationships.—See the "Fifth Report on the Fossil Phyllopoda of the Palæozoic Rocks," read at the Manchester Meeting of the British Association for the Advancement of Science, September 3, 1887 (printed and issued at the same date), pp. 1-3.

I. Ceratiocaris.

Monograph of the British Palæozoic Phyllocarida, Pal. Soc., by T. R. J. & H. W., 1888, pp. 9-13.

1. Ceratiocaris Angelini, T. R. J. & H. W. Plate V. Fig. 1.

Fifth Report, etc., 1887, p. 1.

This unique specimen is a long, stout, trifid caudal appendage, consisting of the style or telson (145 mm. long, and 17 mm. broad at the top) and two stylets (each 75 mm. long) lying close together. One of the latter and the style have been broken across by a crush, and the style is not quite perfect at the tip (possibly 15 mm. longer originally). The lower (ventral) surface only is shown. The articulation of the stylets with and beneath the shoulders of the style—that is, under the backward extension or overhanging hinder edge of its head or proximal end—is very distinct. The upper edge of this part of the style (the surface articulating with the ultimate segment) has an undulated profile, with two small, projecting, unsymmetrical, curved, horn-like processes.

The style on this its lower aspect has a deep groove along the middle of its upper moiety (obscured at the top), becoming narrow lower down. A slight groove on each side is also present. No delicate ridging is seen, nor any pits for bases of prickles. The stylets are smooth, and apparently subtriangular in section, each bearing one strong ridge on the upper part of the under face (as exposed).

In these features this form differs from *C. Bohemica*,[1] Barrande, the telson of which is not deeply furrowed on its ventral (under) face; and the latter species has longer stylets, oval in section, and neatly ridged throughout.

The Scandinavian specimen occurs, as an impression, in hard black shale ('Brachiopod-Skiffer') from the Lower Silurian (Upper Caradoc) of Westergötland (Westrogothia), a province in the western part of the mainland of Sweden. It has been badly figured in Angelin's unpublished 'Tab. LIII.' figs. 18 and 19. Fig. 1 is taken from a plaster cast.

2. Ceratiocaris Bohemica, Barrande. Plate V. Figs. 2—6, 10.

1853. *Ceratiocaris* (*Leptocheles*) *Bohemicus*, Barr. "Neues Jahrb. für Min." etc. 1853, Heft. iii. p. 342.
1868. *Ceratiocaris Bohemicus*, Barr., in Bigsby's "Thesaur. Silur." p. 199.
1872. *C. Bohemicus*, Barr. "Syst. Sil. Bohême," vol. i. Suppl. p. 447, pl. 19, figs. 1–13.
1885. *C. Bohemica*, T. R. J. & H. W. "Third Report on the Palæozoic Phyllopoda," p. 31 (p. 356, Brit. Assoc. Report for 1885); and Fifth Report, etc., 1887, p. 2.

In this species the ultimate segment, 50 mm. long, has a linear longitudinal ornament of interrupted raised lines. The telson more than 112 mm. (4½ inches) in length, is ridged and furrowed, and has pits (marking the bases of former spines and prickles) along the two outer slopes of its dorsal surface. The lower face has a broad median furrow and two lateral hollow slopes. The head of the telson has a linear ornament like that of the ultimate segment. The stylets are ridged and furrowed, and are somewhat oval in section.

Four specimens (Figs. 2, 4, 5, 6), from the cream-coloured limestone (Wenlock Shale) of Ekstа, Gothland, are portions of the shafts of straight, strong styles (telsons), similar to that of *C. Bohemica*, and chiefly from the middle and lower parts of the styles. In section these Scandinavian specimens are more equally quadrate than in Barrande's figs. 7 and 9, pl. 19, "Syst. Sil. Bohême," vol. i. Suppl., and the fluting on the lower face is somewhat different. One piece, Fig. 4, is the same as "fig. 5" of Angelin's unpublished plate "Table B."

Another piece of telson (Fig. 3) of the same kind as the above, shown by a drawing from Stockholm, is from the Sandstone of Bursvik, South Gothland (Wenlock Shale).

A small fragment (Fig. 10) from Lau, Gothland, in cream-coloured fossiliferous limestone (Wenlock), is probably part of a stylet of *C. Bohemica*, comparable with, but much smaller than, figs. 4, 5, of Barrande's pl. 19. It tapers rather rapidly, bears several thin ridges on both faces, and is oval in section.

2*. Ceratiocaris valida (?), J. & W. Plate V. Fig. 7.
Monogr. Foss. Phyll. 1888, p. 20.

This is a fragment of strong thick telson in cream-coloured limestones, differing from *C. Bohemica*: (1) in being curved (the

[1] Syst. Sil. Bohême, vol. i. Supplement, p. 447, pl. 19, figs. 1–13.

convexity is dorsal, that is, on the upper surface), (2) in having the two pitted slopes lower down on the sides, and (3) in the section being less quadrate than in *C. Bohemica* proper. In many respects it approaches *C. valida*, J. & W. In whitish limestone with Strophomena, Trilobites, Tentaculites, Encrinites, etc. (Wenlock Limestone), from Rohne, Gothland.

3. Ceratiocaris, sp. Pl. V. Fig. 9.

1887. *Ceratiocaris*, sp. nov.? T. R. J. & H. W. Fifth Report, etc. p. 2.

A fragment of a style or of a stylet. It is somewhat like the last (Fig. 10), but the ridges are fewer, broader, and rounded. This is a drawing sent from Stockholm. The specimen ("Mus. Geol. Survey Sweden") was from Fröjel, Gothland (Wenlock Shale). The "fig. 6" in "Angelin's" unpublished "Tab. B" is somewhat like this, but shows six, instead of four rounded ridges.

4. Ceratiocaris concinna, T. R. J. & H. W. Plate V. Fig. 8.

1887. *Ceratiocaris concinna*, sp. nov. Fifth Report, etc. p. 2.

A small portion of a straight, rapidly tapering style, convex on the upper, and concave along the lower face. The section is half-moon-shaped in the upper, and more oblong in the lower part. Two rows of small pits on narrow ridges along the back, one on each side of the raised middle. The test is of a dull, light chestnut tint; it is hollow and filled with limestone. From Fröjel, Gothland. This tapering telson (7 mm. broad at the top, and $4\frac{1}{2}$ mm. at the end of the fragment 15 mm. long), differs from any we know of, though it approaches that assigned to *C. patula*, J. & W. Being very neat in aspect, it has been called *concinna*.

5. Ceratiocaris Scharyi, Barrande. Plate VI.[1] Fig. 1.

1872. *C. Scharyi*, Barr. "Syst. Sil. Bohême," vol. i. Suppl. p. 454, pl. 32, figs. 24-29.

1876. *C. Scharyi*, F. Rœm. "Leth. geogn." Th. I. "Leth. pal." Expl. pl. 19, fig. 6.

1885. *C. Scharyi*, T. R. J. & H. W. Third Report, etc. p. 31 (Brit. Assoc. Report for 1885, p. 356): and 1887, Fifth Report, etc., p. 3.

Of this species seven segments (75 mm., ultimate segment 23 mm. long) were described by Barrande. Height of the highest (sixth from the end), 20 mm.; height at the end of the ultimate segment, 10 mm. Proximal portion of the trifid appendage, attached in place, is ornamented with a delicate imbrication of raised, leaf-shaped lines, like pointed arches, with a minute tracery of smaller leaf-like pattern within them: all pointing backwards. The same ornament appears on the head or proximal portion of the telson also. The ornament has some resemblance to the pattern on *Eurypterus*; it occurs also on *C. Deweii*, Hall, and on some British forms. This species belongs to Barrande's Stage E e 1 of the Bohemian formations.

From Scandinavia we have seen seven abdominal segments (first and last imperfect), some with the test, some shown only by

[1] Plate VI. will appear in the April Number Geol. Mag.

impressions; crushed laterally, and showing the whole half from the dorsal ridge to the epimeral border. In shape they are not unlike those of *C. Scharyi*, Barrande. They are ornamented with a strong leaf-like lattice-pattern, as in that species. The apices of some of the triangles thicken and form a kind of elongate drop-like ornament (Pl. VI. Fig. 1 *b*). The smaller (secondary) lattice-work inside each leaf-mark is not so distinct as in Barrande's fig. 27.

In hard blue micaceous shale (Ludlow Series), from the lake Ringsjön, Scania.

This specimen is a portion of "fig. 1" in Angelin's unpublished "Tab. B." That figure shows a large portion of the ultimate segment, and the complete penultimate segment; but the former and a third of the latter have been broken away, and a fracture passes between the two next segments.

6. Ceratiocaris pectinata, T. R. J. & H. W. Plate VI.[1] Fig. 2.

1887. *Ceratiocaris pectinata*, sp. nov. Fifth Report, etc. p. 3.

A portion of an ultimate segment (14×6 mm.), with a telson (fragment 30 mm.) and one stylet (not quite perfect, 22 mm.). The segment retains scarcely any of the test, but shows traces of an ornament of irregular small tubercles and interrupted longitudinal lines; and the distal margin of the segment has a coarse comb-like fringe, consisting of a regular set of thin elongate tubercles, reminding one of the drop-like tubercles on marginal parts of some Eurypterids.

The head of the telson is wrinkled longitudinally, and both the style and the stylet are ridged and furrowed. This form being new to us, its comb-like fringe suggested the name *pectinata*.

In earthy micaceous blue-grey limestone, from the Ringsjön, Scania.

This specimen is "fig. 2" in Angelin's unpublished "Tab. B."

EXPLANATION OF PLATE V.

(All of the Figures of the Natural Size except Fig. 8 *b*.)

Fig. 1. *Ceratiocaris Angelini*, J. & W. View of the underside of the style and stylets. From a plaster cast. The style is not quite perfect.

„ 2 *a*, *b*, *c*. *Ceratiocaris Bohemica*, Barr. Views of a part of the butt-end of a style. *a*, side view; *b*, dorsal aspect; *c*, section.

„ 3, 4 *a*, *b*; 5 *a*, *b*; 6 *a*, *b*. The same. Dorsal views and sections of portions of styles.

„ 7 *a*, *b*. *C. valida* (?), J. & W. Side view and section of a portion of a style.

„ 8 *a*, *b*, *c*. *C. concinna*, J. & W. Views of a broken style. 8 *a*, dorsal view; 8 *b*, a row of pits, enlarged 2 diam.; 8 *c*, sectional area.

„ 9. *Ceratiocaris*, sp. nov. ? View of the underside of a stylet.

„ 10 *a*, *b*. *C. Bohemica*, Barr. View of the underside of a stylet, and its sectional area.

[1] Plate VI. will appear in the April Number of the Geological Magazine.

(*To be continued in our next Number.*)

II.—Further Notes on Carboniferous Selachii.[1]

By Dr. R. H. Traquair, F.R.S., F.G.S.

Anodontacanthus and Pleuracanthus.

In 1881[2] Mr. J. W. Davis proposed the genus *Anodontacanthus* for certain straight spines resembling *Pleuracanthus*, but differing in the absence of the two rows of denticles. Three species are included:—*A. acutus* and *obtusus*, from the Coal-measures of Yorkshire, and *A. fastigiatus*, from the Blackband Ironstone of Carboniferous Limestone age at Loanhead, near Edinburgh.

I offer no criticism on the two Yorkshire species, nor have I seen the type of the Midlothian *A. fastigiatus*. In the large collection of spines which I have from Loanhead, there are, however, many which I refer without doubt to the last-named species. Now, although some of these are smooth and without denticles, others show, in all stages of apparent wearing away, undoubted stumps of denticles, whereby the species *fastigiatus* falls into *Pleuracanthus*, as that genus at present stands.

It is to be noted that a large number of the spines found in this Ironstone (Loanhead and Borough Lee, No. 2) are singularly worn or eroded all over, as if they had been long exposed to the action of agencies, chemical or mechanical, tending to destroy the surface. I have seen a spine of *Gyracanthus* from that bed having every vestige of the surface ornament, so elaborate in that genus, removed, and I had to examine it microscopically before I felt absolutely sure of its genus. Other *Gyracanthi*, etc., are found in every stage of "polishing off." But this phenomenon is by no means peculiar to the spines and other fish remains from Loanhead; it is tolerably frequent elsewhere, and is apt to lead into error those who have not yet learned to take it into account. *Pleuracanthus erectus*, Davis (Q.J.G.S. vol. xxxvi. p. 326), is to my mind nothing but an eroded specimen of *Pl. lævissimus*, Ag., the "very blunt-pointed" character of the denticles being thus amply accounted for, and I have a specimen of *Pl. elegans*, Traq., from Loanhead, which shows precisely the same condition. *Pl. Wardi*, Davis (*ib.* p. 334), probably owes the bluntness of its denticles to the same cause. And I feel pretty well persuaded that T. Stock's *Lophacanthus Taylori* (Ann. and Mag. Nat. Hist. 5th ser. vol. v. p. 217) is nothing but a worn specimen of *Pleuracanthus* (*Orthacanthus*) *cylindricus*, Ag.

Pristodus falcatus, Davis (ex Agassiz MS.).

Mr. Davis, in his large work on the Carboniferous Limestone Fishes of Great Britain, in describing a remarkable tooth to which Agassiz had given the MS. name *Pristodus falcatus*, makes no reference to the fact that a closely allied species had been already, in 1875, figured and described by Mr. R. Etheridge, jun., in the Geological Magazine, under the name of *Petalorhynchus? Benniei*.[3]

Mr. R. Etheridge also mentions that he had been informed by

[1] Read before the Royal Physical Society of Edinburgh, February 15th, 1888.

[2] Q.J.G.S. vol. xxxvii. p. 427.

[3] Geol. Mag. Dec. II. Vol. II. p. 242, Pl. VIII. Figs. 3 and 4.

Mr. W. Davies[1] that Mr. W. Horne had exhibited a similar tooth from Wensleydale at the Bradford meeting of the British Association in 1873, and goes on to say:—"Mr. Davies is also much impressed with its resemblance externally to the uncovered teeth of the Parrot fishes generally, but more especially to the *Diodons*; but as the fish which bore this tooth was undoubtedly a Selachian, and the structure of the tooth, within the mouth, so different to that of the *Diodons*, it can have no affinity with these recent fishes, although very suggestive of a Selachian with a similar form of mouth." This statement as to affinities by Mr. R. Etheridge, jun., cannot be called in question by any one who has studied the structure of the teeth and jaws of *Diodon*; nevertheless, six years afterwards, we find Mr. J. W. Davis, at the British Association in 1881, naming this tooth *Diodontopsodus*, and apparently going back to the idea of its Gymnodont affinities: "In *Diodontopsodus* the teeth are extremely like those of the existing fish *Diodon*" (Proc. Brit. Assoc. 1881, Trans. Sect. p. 646). And in his large work on the Carboniferous Limestone Fishes he seems still unable to free himself from this idea. At p. 521 he says:—"In searching for the zoological relationship of *Pristodus*, a striking and most peculiar resemblance is at once observed between it and some of the Gymnodont group of the Plectognath group of fishes at present existing. . . . In many respects the fossil teeth from the Mountain Limestone of Yorkshire bear considerable resemblance to those of *Diodon*. In the general form of the palatal interior, combined with the semicircular external, trenchant edge of the tooth, the two are almost identical. . . . A comparison of the recent and fossil teeth, however, leads to a natural inference of relationship in some degree, however remote. Evidence is entirely wanting as to the anatomical structure of *Pristodus*, and I do not wish to lead to the inference that it was more nearly related than is warranted by the peculiar similarity of the teeth." I very much fear however that the "peculiar similarity of the teeth" is a very deceptive one after all.[2]

But although *Pristodus* cannot have had the remotest *affinity* with *Diodon*, it is quite an open question as to whether there may not have been some analogy in the form of the jaws, a couple of these peculiar tooth-plates, one above and one below, forming the whole of the armature of the mouth. Rather against this view, however, is the fact that the height of the crown in these teeth is extremely variable, as may be well seen in the extensive series of *P. falcatus* in the British Museum, and that in some the apex is more acute, or tending to be mucronate, than in others.

Mr. J. W. Davis's *Pristicladodus concinnus* seems to me to be nothing more or less than a crushed specimen of a species of *Pristodus* with a more than usually mucronate apex.

[1] Formerly of the British Museum.

[2] My friend Mr. A. Smith Woodward writes to me that he has, from an examination of specimens from Derbyshire, come to the conclusion that *Pristodus Bennieï* (R. Eth., jun.) is after all distinct specifically from *P. falcatus*, Ag. *Concinnus* (Davis) he also is inclined to regard as distinct, and in that case all three names will stand as species of *Pristodus*.

Pristicladodus, M'Coy.

There can be no doubt that the specimen from Armagh, in the British Museum, to which Mr. J. W. Davis has given the name of *Carcharopsis Colei*, is nothing else than a specimen of *Pristicladodus dentatus*, M'Coy, with the base broken off.

Chondrenchelys problematica, n. gen. & sp.

Among the fishes from the Eskdale beds, obtained from Mr. Damon for the Edinburgh Museum, is one whose nature is still more problematical than that of *Tarrasius*, which it somewhat resembles in external shape. Two specimens in the Edinburgh Museum have the head and the tail preserved up to near the termination of the latter, and of these the lengths are, respectively, $4\frac{3}{4}$ and 7 inches. The shape of the body is singularly elongated and eel-like, the head being small, less than $\frac{1}{5}$ of the total length, while a long, low, continuous dorsal fin runs along the back from not far behind the head to the end of the slender pointed tail.

In the larger of these two specimens no structure can be made out in the head at all, owing to the obstinacy with which a layer of matrix adheres to the surface.

The smaller affords not much more light as to this part, though the shape of the head appears pointed, and there is some appearance of what is either a mandible or a palato-quadrate arch. It is even difficult to make out whether the substance exhibited be true bone, or calcified cartilage, though there is a spicular-looking body lying longitudinally in the middle of the head, which from its smooth, almost glistening, aspect reminds us of bone. About $\frac{1}{5}$ inch behind the head, and apparently not at all attached to it, is an evident shoulder-girdle, or coraco-scapular arch, whose direction is obliquely downwards and forwards. Careful examination reveals no composition out of distinct membrane-bones; on the other hand, its substance has an unmistakeably granular aspect suggestive of calcified cartilage. No trace of paired fins, pectoral or ventral, is visible.

Commencing at the head, and passing back under the aforesaid shoulder-girdle to the extremity of the tail is a well-marked vertebral column. Here the axis consists of undoubted centra, which are rather higher than long. They are crushed and flattened laterally, but on careful examination of a most instructive fragment in the collection of the Geological Survey of Scotland, they can clearly be made out to have had the configuration of thin-walled hollow rings, through which a scarcely constricted notochord must have passed. Appended to the dorsal aspect of this chain of centra is a series of bodies representing the neural arches and spines. Each of these is short, slender, and rod-like, bifurcating below and pointed above, and there seems to be one for each centrum. They are not composed of ordinary bone, but of small granules placed end to end like a string of beads, and that they had not the rigidity of bone is seen from the flexuosities which they often present in their contour. Commencing almost immediately behind the shoulder-girdle, and appended to the neural spines above, is a second series of rod-like bodies represent-

ing fin-rays or radials, of which there are three or four to each neural spine; they are more slender than the latter, but have the same granular structure. They gradually increase in length towards the posterior third of the body, whence they again fall away towards the end of the tail. The abdominal region extends for 1⅜ inch behind the head: no ribs are visible, the termination of the abdomen being marked by the commencement of a series of hæmal elements quite similar in configuration and structure to the neural ones above, and these now extend to the extremity of the tail. No fin-rays are seen on the ventral aspect of the skeleton, nor have I seen any trace of any dermal hard parts.

This is indeed one of the strangest fishes as yet yielded by these Eskdale deposits, which have proved so rich in palæichthyological treasures. We are not aware of any ganoid, recent or fossil, whose body is entirely destitute of dermal hard parts, for even the all but naked *Polyodon* of the present day and also the Carboniferous *Phanerosteon* have still a few scales on some part of their surface. It seems also scarcely probable, that the apparent absence of membrane bones from the head and shoulder-girdle is entirely due to deficient preservation, and the granular structure of the vertebral apophyses and radials is not paralleled so far as I know in any Ganoid. It certainly is not an ordinary Ganoid, nor is it an Acanthodian. On the other hand, its affinity to the Selachii seems to be indicated by the position of the shoulder-girdle, and by the granular calcification of the vertebral apophyses and radials, and probably also of the head and shoulder-girdle. If it be a Selachian, it is certainly one of a very primitive and at the same time aberrant type. In its long dorsal fin, it resembles *Xenacanthus*, but there is no cephalic spine, apparently no paired fins (though this may indeed be due to defective preservation), the vertebral centra are more developed, and the two rows of dorsal interspinous cartilages or "Flossenträger" described by Kner in that genus seem to be absent. It is certainly a new, as well as a most interesting form, for which I accordingly propose the name of *Chondrenchelys problematica*.

III.—On the Detection of Mural Pores in thin Sections of the Favositidæ.

By H. Alleyne Nicholson, M.D., D.Sc., F.G.S.,
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As a text for the following brief remarks on the recognition of mural pores in thin sections of the Favositoid Corals, I may quote a note appended by Mr. James Thomson, F.G.S., to a recent paper on the genus *Lithostrotion* (Trans. Edin. Geol. Soc. vol. v. part iii. p. 381). The note in question is subjoined, the quotation being *verbatim*, and, I may add, *literatim* also:—

"We may, however, attach an undue importance to microscopic examinations. Need I refer to the point raised recently by that erratic and energetic worker, Prof. Alleyne Nicholson, regarding mural pores in the genus *Alveolites*, the type of which is also in Dr.

Fleming's collection. If he had detected mural pores in microscopic sections, we would have regarded such as being one of the greatest discoveries of modern times. Is it to be expected that such delicate pores could retain their normal aspect, surrounded and impregnated by induced calcareous matter during fossilisation? Indeed, we have failed in detecting the mural pores in the genus *Michelinia* by the microscope, which is of gigantic proportions in comparison to any of the four species of *Alveolites*. In, however, weathered specimens of either we find no difficulty in detecting the mural pores, and in no locality have we procured better examples showing such than is to be found in the examples of *A. depressa*, found in Charleston Quarry, Fifeshire. A variety of *Alveolites*, which we believe has been rashly relegated to the genus *Chœates hyperbolus*,[1] by Nicholson and Etheridge, jun."

So far as concerns the genus *Alveolites*, Lam., in particular, it is unnecessary to criticise the statements contained in the above note; since the note itself contains the plainest proof that Mr. Thomson does not know what the genus *Alveolites*, Lam., *is*, and that he is not acquainted with any species of the same. The first point is sufficiently shown by his assertion that "the type" of the genus is "in Dr. Fleming's collection"; whereas the type of the genus *Alveolites*, as every palæontologist knows, is the familiar *A. suborbicularis*, Lam., of the Devonian rocks, and is preserved at Paris. The second point is equally clear from his speaking of "the four species of *Alveolites*," as if there were only four species in the genus; the truth being that "the four species" to which he refers (viz. *Chætetes septosus*, Flem., *C. depressa*, Flem., *C. capillaris*, Phill., and *C. Etheridgii*, Thoms.) belong to the genus *Chætetes*, Fischer, and are not referable to the genus *Alveolites*, Lam., at all.

As regards the general question involved, in view of all that has been published in recent times as to the minute structure of the Favositoid Corals by Ferd. Roemer, Lindström, Schlüter, Frech, Foord, R. Etheridge, jun., the present writer, and others, it is difficult to believe that one who professes to have studied Palæozoic Corals should speak of the recognition of mural pores in thin sections of *Alveolites* as still unaccomplished,[2] or of its possible accomplishment as being "one of the greatest discoveries of modern times." Even in the days of those great masters—Milne Edwards and Haime—before the method of working by means of thin sections had come into use at all—it was a familiar fact that mural pores could readily be recognized in polished slabs of the Favositoid Corals. Mr. Thomson does not appear to have grasped the elementary fact

[1] By "the genus *Chœates hyperbolus*" Mr. Thomson refers, I presume, to the "species" described by Mr. R. Etheridge, jun., and myself, under the name of *Chætetes hyperboreus*.

[2] Mr. Thomson's disbelief in the possibility of recognising mural pores in thin sections of the Favositoid Corals is, it may be noted, of comparatively recent growth. Thus, in a paper published in the Proceedings of the Philosophical Society of Glasgow in 1881, Mr. Thomson described and figured what he believed to be mural pores in thin sections of *Chætetes Etheridgii*, Thoms. sp. A reference to his figure (*loc. cit.* pl. i. fig. 7) will show, however, that in this case the supposed "mural pores" are represented *in the centre of the calcite filling the visceral chambers of the corallites*, and that they are really nothing more than minute granules of calcite.

that whatever is shown by a polished vertical or horizontal slice of a Coral will necessarily be shown by corresponding thin sections. A thin section often shows *more* than a polished slab, but never *less*. Every one who has ever examined polished specimens of such common Devonian species of *Alveolites*, as *A. suborbicularis*, Lam., *A. Battersbyi*, E. & H., or *A. reticulata*, E. & H., knows that such, as a rule, exhibit the mural pores with the utmost clearness, This being the case, it follows, as a matter of course, that thin sections of such forms show the mural pores, to one who knows what to look for, with at least equal clearness. What is true of the above-mentioned forms is true of the Favositoid Corals generally, in thin sections of which mural pores can usually be detected without any difficulty. This assertion is not at all affected by the fact that in certain states of mineralization any form of the *Favositidæ may* fail to yield direct evidence of mural pores, when examined either in polished slabs or in thin sections.

The phenomena by which we may recognize in thin sections of the Favositoid Corals the presence of mural pores are, of course, well known to palæontologists generally. For the benefit, however, of those who may be beginning the study of the fossil Corals by means of thin sections, I may briefly indicate the character of these phenomena.

In the first place, it is to be remembered what "mural pores" are. In their typical form, mural pores are simply rounded or oval apertures, arranged in longitudinal series, which perforate the walls of adjacent corallites and place adjoining visceral chambers in direct communication. In some cases, the "mural pore" is not completed; since the thin "primordial wall" which separates adjacent tubes is not actually perforated, but is continuous. In such cases, the cavities of adjacent tubes do not actually communicate, and the so-called "mural pore" is simply caused by a deficiency, at corresponding points, of the thick layer of secondary sclerenchyma ("stereoplasma") which ordinarily coats both sides of the "primordial wall." In other cases, again, as in the genus *Roemeria* and in the typical species of *Pachypora*, where the above-mentioned layer of secondary sclerenchyma is excessively thick, the "mural pores" assume the character of longer or shorter *tubes* which connect adjacent visceral chambers. Whatever may be the precise form assumed by the mural pores, they can usually be readily recognised in thin sections, whether these sections be taken at right angles to the tubes or in a direction corresponding with the long axes of the latter. The facility with which they can be detected depends partly upon the condition of preservation of the specimen examined and partly upon the size and arrangement of the mural pores themselves. With regard to the latter point, the large, often uniserial pores of forms like *Alveolites* and *Pachypora* are usually more conspicuous than the generally smaller, often biserial or triserial pores of *Favosites* and its immediate allies.

Bearing the nature of "mural pores" in mind, it is easy to recognize the phenomena which they present in thin sections.

1. *Tangential Sections.*—Sections taken tangentially to the surface of a Favositoid Coral, so as to cut the corallites at right angles to their length, very commonly exhibit the mural pores. In such cases the mural pore presents itself as a gap in the wall forming the circumference of a corallite (Fig. 1, *A*, *B*, and *C*, *p*), the size of this gap depending upon the size of the pore. If the mural pore is not a complete perforation (as sometimes happens), then the gap is crossed by the thin primordial wall of the corallite, the delicate partition thus formed being uncovered on both sides by the layer of

Fig. 1.

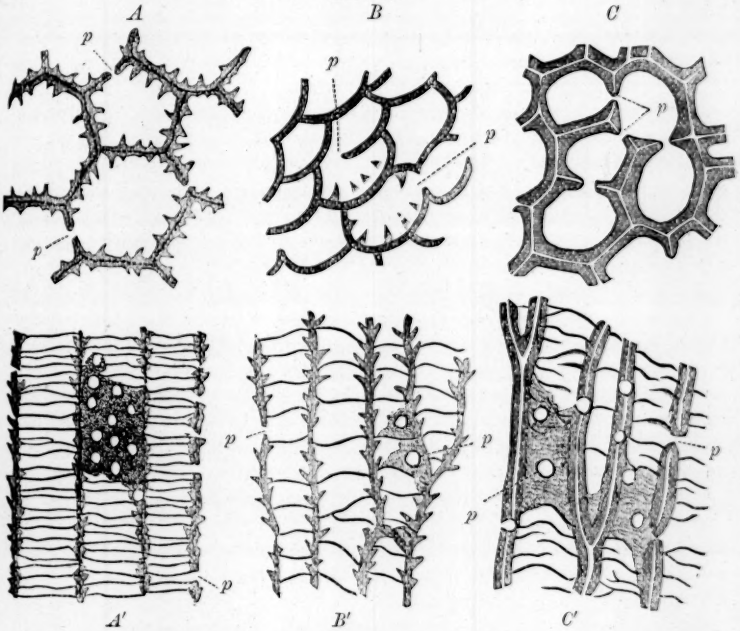

Fig. 1.—Thin sections of Favositoid Corals, showing the phenomena presented by the mural pores. *A*, Tangential section of *Favosites* sp., from the Devonian of Queensland, enlarged six times. *A′*, Vertical section of the same similarly enlarged; in two of the tubes the section traverses the centre of the visceral chambers, but in one it corresponds in part with the wall of the corallite. *B* and *B′*, Tangential and vertical sections of *Alveolites Labechei*, E. & H., from the Wenlock Limestone of Ironbridge, enlarged ten times. [The septal thorns which characterize this species, as also *A. Battersbyi*, E. & H., are mostly omitted in the drawing.] *C* and *C′*, Tangential and vertical sections of *Pachypora* sp., from the Corniferous Limestone of the Falls of the Ohio, enlarged ten times. In all the figures the letter *p* indicates the mural pores.

secondary sclerenchyma which elsewhere lines the wall. In the great majority of well-preserved specimens of species of *Favosites*, *Pachypora*, *Striatopora*, *Michelinia*, *Pleurodictyum*, *Alveolites*, etc., there is usually no difficulty in recognizing the presence of mural pores by the more or less frequent occurrence in tangential sections of the deficiencies in the walls of the corallites above described. In

Alveolites itself, the mural pores are generally uniserial, and are placed along the *short* sides of the compressed corallites; so that they appear in tangential sections as gaps at the *ends* of the crescentic tubes (Fig. 1, *B*). It is hardly necessary to add that a tangential section is very unlikely to traverse more than an *occasional* mural pore. It is, therefore, only here and there in such a section that we should find the deficiencies in the walls of the corallites due to the presence of mural pores; and in some sections we might fail to find any traces of the pores.

The only appearance which, so far as I know, could be confounded with the above is the apparent communication between two adjacent corallites seen in tubes of *Chætetes*, and of certain other types, as viewed in tangential sections. In these latter cases, however, it is not that *two* adjoining corallites are placed in communication by a perforation in their wall, but that *one* corallite is imperfectly separated into two by the extension into the visceral chamber of a septiform plate, the result of commencing fission. It is hardly possible for a practised observer to confound the appearances produced in this way with those due to the presence of mural pores; and in any case an examination of longitudinal sections would at once show the true nature of the phenomenon.

2. *Vertical sections traversing the visceral chambers of the corallites.*—Vertical sections of the Favositoid Corals—*i.e.* sections cutting the tubes longitudinally—usually in part traverse the *visceral chambers* of the corallites, while in part they coincide more or less closely with the *walls* of the corallites. In the former case, the section exhibits the infilling of the tube (calcite or mud), intersected by the tabulæ and bounded laterally by the longitudinally divided wall of the corallite on each side (Fig. 1, *A'*, *B'*, and *C'*). In such cases, the presence of mural pores can commonly be recognized by the more or less frequent occurrence of gaps or deficiencies in the wall on each side, the cavity of the tube being thus placed in communication with adjoining visceral chambers. The phenomena presented in these cases are precisely similar to those shown in tangential sections, and need no special notice. As in the latter, it is only here and there that the line of section happens to coincide with a mural pore, and it is, therefore, only here and there that we observe in long sections the gaps in the bounding-walls of the corallites caused by the presence of pores, the size and number of these gaps depending directly upon the size and number of the pores. As a rule, however, the presence of mural pores can in this way be readily recognized in thin vertical sections of *Favosites*, *Michelinia*, *Pachypora*, *Alveolites*, and the other Favositoid Corals (see Fig. 1).

For obvious reasons, longitudinal sections which more or less closely coincide with the centre of the visceral chamber of a corallite cannot exhibit any signs of mural pores other than the gaps just mentioned in the bounding-walls of the tube. In other words, no trace of the mural pores can be found in the calcite or mud which occupied the space between the bounding-walls. It is not uncommon, however, to find certain structures in the calcitic infilling of the

corallite which may readily be mistaken for mural pores. The structures to which I allude present themselves as rounded dark dots arranged in lines, and presenting very much the appearance of being pores. In reality, these structures—which have sometimes been confounded by various observers (including myself) with mural pores—are the cut ends of septal spines or thorns, which project into the cavity of the corallite, and thus come to be divided in sections across the visceral chamber.

3. *Vertical sections coinciding with the walls of the corallites.*—As above mentioned, most vertical sections of the Favositoid Corals come here and there to traverse the *walls* of the corallites. This is inevitable when we reflect that the corallites are usually more or less curved, so that it is hardly possible for a vertical section to divide any single corallite along its whole length in a single plane. Hence, a section which in one place cuts a tube through the centre of the visceral chamber may in another place divide the same tube along one of its bounding-walls (see Figs. 1 *A′ B′* and *C′*). Whenever the plane of a vertical section comes to coincide with the plane of the wall of a corallite, the mural pores are necessarily shown more or less extensively as round or oval perforations in the wall, the latter appearing as a more or less opaque space replacing the calcitic infilling of the visceral chamber (Fig. 1 *A′*). Almost all vertical sections of well-preserved examples of *Favosites*, *Pachypora*, *Michelinia*, *Alveolites*, etc., show the appearances here described at certain points; and when this is the case, the presence of mural pores can never be doubted. In certain species of *Favosites*, however, as for example in *F. aspera*, D'Orb., and *F. Mullochensis*, Nich. and Eth. jun., vertical sections may fail to show the mural pores, owing to the fact that these openings are placed at the *angles* of the prismatic tubes, instead of along the *flat faces* of the corallites. In the species of *Alveolites*, also, owing to the position of the pores on the *short sides* of the corallites, vertical sections often fail to show the appearances just described, since the parts of the wall exposed in such sections commonly belong to the *wide non-poriferous faces* of the corallites.

If an investigation of a coral otherwise similar to the *Favositidæ* should fail to bring to light any of the phenomena above described as indicating in thin sections the presence of mural pores, it may in general be safely concluded that such a Coral is "imperforate." At the same time, it is not safe in all cases to conclude that mural pores are wanting merely because their presence has not been detected in one or two thin sections. There are plenty of cases where a single thin section exhibits no traces of mural pores, but where abundant evidence of the presence of these structures can be obtained by an investigation of a *series* of such sections. There are also cases where a specimen of a form certainly known to possess mural pores may nevertheless fail to show signs of these in thin sections, as the result of complete recrystallization or replacement. Such cases are, however, rare, and do not affect the general value of the characters above pointed out.

In conclusion, I may add that I have carefully examined a very extensive series of thin sections of the four types of Carboniferous Corals which Mr. Thomson speaks of as "the four species of *Alveolites*," and I have failed to find in a single instance any indication of any of the phenomena above mentioned as caused by the presence of mural pores. I have therefore no doubt that the corallites in these four types possessed imperforate walls; while the general structural features which they present render it certain that they are truly referable to the genus *Chætetes*, Fischer.

IV.—Notes on Tertiary Lacertilia and Ophidia.

By R. Lydekker, B.A., F.G.S., etc.

A RECENT examination of the remains of Tertiary Lacertilia and Ophidia preserved in the British Museum having brought to light some new facts in regard to distribution, and also indicating the necessity of revision of certain determinations of other authors, I have thought it advisable to communicate the result of my observations in a collective form.

Iguana.—In his description of the vertebrates of the Quercy Phosphorites Dr. Filhol[1] describes and figures two fragments of the jaws of a small Lizard which he refers to the American genus *Iguana*, under the name of *Iguana europeana*, although in the description of the plate[2] they are mentioned as *Proiguana*. Among the Hastings collection from the Upper Eocene (Oligocene) of Hordwell in Hampshire I find several vertebræ (No. 32840, A) of a small Lizard, which show the minute zygosphenes characteristic of the *Iguanas*, and agree in all other respects with the vertebræ of existing forms. I have, therefore, no hesitation in referring these specimens to the *Iguanidæ*; and since (as I shall again have occasion to mention) at least a certain proportion of the Hordwell and Quercy Squamata appear specifically identical, I think it is not impossible that these specimens may belong to *I. europeana*. With regard, however, to the reference of this species to the genus *Iguana*, it will, of course, be necessary to use that term in a much wider sense than in recent herpetology, where it is restricted to two species; but if the type European form be eventually found decidedly different, the name *Proiguana* might be adopted. The occurrence of such an essentially American type in the European Tertiary is paralleled by the occurrence in the Œningen beds of the genus *Chelydra* among the Chelonia; and also of *Latonia* among the Ecaudata, which is closely allied to, if not identical with, the Brazilian *Ceratophrys*.

Placosaurus.—In his "Zoologie et Paléontologie Françaises," 2nd ed. p. 260, pl. lxiv. fig. 2, the late Prof. P. Gervais described and figured part of the cranium of a Lizard from the Upper Eocene (Lower Oligocene) of Vaucluse under the name of *Placosaurus rugosus*; of which the most characteristic feature is the presence of an armour of sculptured polygonal dermal scutes on the upper surface. Many years later the same writer in his "Zoologie et Paléontologie

[1] Ann. Sci. Géol. vol. viii. p. 267. [2] *Op. cit.* p. 338.

Générales," sér. 2, p. 60, gave a woodcut of the cranial scutes of another Lizard from the approximately equivalent Phosphorites of Quercy under the name of *Varanus margariticeps*, making, however, no reference whatever to *Placosaurus*. Now if the type specimens of these two forms be compared together, there cannot, I think, be much hesitation in acknowledging their generic identity; while it is perfectly clear from the presence of dermal scutes that they have nothing whatever to do with the *Varanidæ*. At a still later period Dr. Filhol[1] described and figured from the Quercy Phosphorites an imperfect dentary bone under the name of *Palæovaranus cayluxi*, and suggested that it might be the same as the so-called *Varanus margariticeps*; but since this specimen appears to belong to a true *Varanus*, it will be perfectly distinct from the latter. In the collection of the British Museum I find, however, a number of vertebræ belonging to Lizards of medium dimensions, from Quercy (No. R. 428), and also others of similar type from Hordwell (No. 32840), which agree most nearly with those of certain existing genera of *Anguidæ*, and appear decidedly distinct from those of the *Varanidæ*, although there is a great general resemblance between the vertebræ of the two families. This would lead to the conclusion that since *Placosaurus* agrees with the *Anguidæ* in the presence of dermal scutes, the vertebræ in question belong to the Quercy species of that genus. I find, moreover, a dentary bone of a Lizard from Quercy (No. R. 377) agreeing very closely with the dentary of the existing genera *Diploglossus* and *Ophisaurus*; and the presumption is therefore very strong indeed that this specimen is likewise referable to the Quercy *Placosaurus*. It appears, however, to be indistinguishable from a fragmentary dentary from Quercy figured by Dr. Filhol in pl. xxvi. fig. 425 of the work cited under the name of *Plestiodon* (= *Eumeces*) *cadurcensis*; that genus belonging to the family *Scincidæ*. That the present specimen is, however, not a Scincoid is decisively shown by the absence of the descending ridge from the coronoid on the outer aspect of the posterior extremity of the dentary, which forms such a characteristic feature in that family. Finally, on comparison of a Quercy femur (No. R. 387) with the similar specimen figured by Dr. Filhol (*op. cit.* pl. xxvi. figs. 445–446) under the name of *Palæovaranus*, I find a marked resemblance to the femur of the Anguoid genus *Diploglossus* and a wide difference from that of *Varanus*.

The foregoing evidence tends therefore to show that all the above-mentioned specimens are in all probability referable to the genus *Placosaurus*; which accordingly appears to have been a member of the *Anguidæ* provided with well-developed limbs. There is no evidence to show whether the Quercy form is really distinct from the typical Vaucluse *P. rugosus*; but for the present it may perhaps be advisable to retain the specific name *margariticeps*, of which *Plestiodon cadurcensis* appears to be a synonym. The Hordwell form may belong to either the Vaucluse or the Quercy representative of the genus, if these be distinct. And I may add that the North American

[1] *Op. cit.* p. 268, pl. xxvi. fig. 434 (1877).

Eocene genera *Saniva*, Leidy, and *Glyptosaurus*, Marsh, are in all probability closely related to *Placosaurus*.

Paleryx and *Palæopython*.—The genus *Paleryx* was founded in 1850 by Sir R. Owen [1] on the vertebræ of a comparatively large snake from the Hordwell Beds, which was regarded as nearly allied to the existing genus *Eryx*. In 1880 M. Rochebrune [2] described and figured certain Ophidian vertebræ from the Quercy Phosphorites under the new generic title of *Palæopython*; identifying one species with *Python cadurcensis* of Dr. Filhol,[3] and naming a second species *Palæopython Filholi*. On comparing vertebræ from Quercy in the Museum (No. R. 428, A) which are indistinguishable from the specimen figured by Rochebrune as *Palæopython cadurcensis* with the type vertebra of *Paleryx rhombifer* (No. 25259), I find that the two cannot be even specifically distinguished. Similarly I find that smaller vertebræ from Quercy (No. R. 428, D) agree precisely with the types (No. 25261) of the Hordwell *Paleryx depressus*, Owen; and I believe that these are in all probability specifically identical with slightly larger Quercy vertebræ (No. R. 428, C), agreeing with the type of *Palæopython Filholi*, Rochebrune. It appears, therefore, that the genus *Palæopython* is identical with *Paleryx*, and should accordingly be abolished; but I agree with M. Rochebrune in regarding the vertebræ to which this name was applied as indicating a Snake very closely allied to *Python*, and clearly referable to the same family.

Palæophis.—The vertebræ of huge Serpents from the London and Bracklesham Clays, described by Sir Richard Owen in the memoir above cited as *Palæophis*, were regarded by him as allied to the marine *Hydrophidæ*. Other vertebræ of similar structure were subsequently obtained from marine Eocene beds in North America, and described by Prof. Marsh under the name of *Titanophis* (*Dinophis*), although regarded by Prof. Cope as generically indistinguishable from *Palæophis*. Both these writers suggested that these Serpents were more nearly allied to the *Pythonidæ* than to the *Hydrophidæ*; and in the memoir which I have already quoted M. Rochebrune came to the conclusion that they should be included in the *Pythonidæ*. If, however, the vertebræ of *Palæophis* be compared with those of *Python*, it will be seen that they differ by their much taller neural spine, by the lower position and different contour of the costal articulation, by the much less prominent zygapophyses, by the more developed hæmal carina, as well as in several minor features; and it would thus appear that on osteological grounds alone the reference to the *Pythonidæ* cannot be maintained. This inference is, however, supported by other considerations. Thus the existing Pythons are confined to the Old World and Australia; and, although they can and do swim well in freshwaters, they are essentially land snakes. Judging, however, from the strata in which *Palæophis* and *Titanophis* occur, there is a very strong presumption, as Sir R. Owen and Prof. Marsh have pointed out, that

[1] Reptilia of London Clay (Mon. Pal. Soc.), pt. 3, p. 67.
[2] Nouv. Archiv. d. Muséum, ser. 2, vol. iii. p. 277, pl. xix.
[3] Ann. Sci. Géol. vol. viii. p. 270 (1877).

these Serpents were of marine habits; and the occurrences of closely allied, if not generically identical, forms on both sides of the Atlantic tends to confirm this view. In addition, therefore, to the osteological differences between *Palæophis* and the *Pythonidæ*, we have in all probability to add the difference of marine against terrestrial habits; and these two differences appear to me to leave little doubt as to the right of the former genus to represent a distinct family type—the *Palæophidæ*. There is, unfortunately, no skeleton of *Hydrophis* accessible to me for comparison with *Palæophis*, but since M. Rochebrune states that the vertebræ of the former are widely different from those of the latter, I think, for the present at any rate, it will be advisable to retain the *Palæophidæ* among the true Colubriformes, where they may be placed after the *Pythonidæ* and allied families.

In conclusion I may observe that figures of some of the specimens I have here mentioned will be given in the British Museum Catalogue of Fossil Reptilia and Amphibia, where attention will be somewhat more fully directed to the question of the specific identity of some of the forms to which I have alluded.

V.—On the Effect of Continental Lands in altering the Level of the adjoining Oceans.[1]

By Professor Edward Hull, LL.D., F.R.S.,
Director of the Geological Survey of Ireland.

THE effect of the attraction of continental land upon the oceanic waters adjoining seems to have been very much overlooked by British physical geographers. That some slight effect arises in the direction of elevating the surface of the ocean in proximity to the coast is generally admitted, but the amount of rise is considered to be small, perhaps insignificant. The prevalence of these views was attributed by the author to the widespread influence of Lyell's hypothesis of the uniformity of the ocean-surface all over the globe.

The author's attention had been called to the subject by the perusal of the works of the German geographers Suess[2] and Fischer,[3] especially the latter; and he had received great assistance in his investigations from Professor G. G. Stokes, M.P., Pres.R.S., and from the Rev. Maxwell H. Close, F.G.S., which assistance he gratefully acknowledged.

In attempting to determine the relative levels of the ocean-surface along the margins of continents as compared with those of mid-oceanic islands, the German authors above quoted had based their results on observations of the length of the second's pendulum. Many years ago (1849) Stokes had shown that the force of gravity must be greater in such islands than on continental stations,[4] and

[1] The paper will probably be published *in extenso* in the Scientific Transactions of the Royal Dublin Society (1888).

[2] Suess, *Das Antlitz der Erde* (1887).

[3] Fischer, *Untersuchungen über die Gestalt der Erde* (1886).

[4] Stokes, *Cambridge Philosophical Transactions*, vol. viii. pp. 672-695.

this conclusion corresponded with actual observations on the length of the second's pendulum at stations all over the globe as tabulated by Airy.[1] The formula of Suess and Fischer based on these was to the effect that the difference in the level of the ocean between two such stations was found in *mètres* by multiplying the difference in the number of daily oscillations in the second's pendulum by 122. This in the case of the stations of California (or Mexico ?) in lat. 21° 30′ and of the Sandwich Islands would amount to 4520 feet: a very startling result if correct.

The author proceeded to discuss the effect of continental lands, showing that this was in the first instance divisible under two principal heads: The effect (1) of the unsubmerged, and (2) of the submerged masses. In the former case (*i.e.* where the mass rose above the surface), one component of the attraction acted in a more or less vertical direction; in the second case, all in a lateral direction; but both had the effect of elevating the surface of the ocean. The horizontal distance to which the vertical effect extended owing to the curvature of the earth's surface was then considered; and it was shown that, where continental lands rise from a deep ocean, the effect of the lateral attraction far exceeds that of the vertical attraction of the unsubmerged mass. Professor Stokes had furnished the author with a hypothetical case, in which the elevation of the ocean was estimated to reach 400 feet above the mean geodetic surface of the earth.

For the purposes of illustration three cases were selected, viz.:—

(1) The table-land of Mexico, between lats. 18° and 26° N.
(2) The table-land of Bolivia, ,, 19° and 25° S.
(3) The Andes of Chile, ,, 26° and 35° S.

The mean elevations, distances from the ocean, and extent having been determined, and the mean density of the crust being taken at 2·6 for emergent, and 1·6 for submerged, land, the results of the attraction of the mountain masses in each case were as follows:—

(1) Mexico, 230 feet; (2) Bolivia, 301 feet; (3) Chile, 63 feet; the elevations being calculated above a mean geodetic surface.

To the above results, due to the gravitation-potential of the elevated masses, were to be added those due to the following factors:—

(*a*) The marginal plain or emergent tract on either side of the mountain mass.
(*b*) The high lands both to the north and south of the special sections above dealt with.
(*c*) And lastly, and most important, the submerged continental mass.

To provide for the sphericity of the earth deductions of various amounts, according to circumstances, were made from the numbers obtained from the formula which Mr. Close had arrived at by a double process, and which is given at length in the paper itself.

Combining these results with those given above, we obtain as the whole rise of the ocean surface as follows:—

(1) Mexico, 780 feet; (2) Bolivia, 2159 feet; (3) Chile, 1582 feet.

In all the above cases the coast was taken as descending to a

[1] Airy, "On the Figure of the Earth," *Encyclop. Metropolitana.*

depth of 15,000 feet at a gradient of about $\frac{1}{44}$ to $\frac{1}{50}$, the comparatively low results in the case of Chile being due to the narrowness of the mountain range, 30 miles in mean breadth, as compared with 300 miles in the case of Bolivia.

The above results, which are probably rather under than over estimates, fall considerably short of those to be drawn from Suess and Fischer's formula, but are probably much in excess of the views held by British physical geographers generally; and the conclusion was drawn, that if the same processes of reasoning and calculation were applied to all parts of the world, it would be found that the ocean waters are piled up to a greater or less extent all along our continental coasts, producing very important alterations in the terrestrial configuration as compared with an imaginary ellipsoidal, or geodetic, surface, to which all these changes of level must necessarily be referred.

VI.—The Occurrence of Variegated Coal-measures, Altered Ironstones, etc., at Swadlincote, Derbyshire.

By W. S. Gresley, F.G.S.

A HIGHLY interesting and remarkable instance of altered Coal-measures, due to impregnation by hydrous and anhydrous oxides of iron, infiltrated by water from the overlying Permian strata, can now be seen *in situ* in the Ashby-de-la-Zouch Coal-field, and I think it should be made known in order that those who may wish to study such phenomena may have the opportunity of doing so. The following is a general description of the section.

The section may be seen near the Fire-brick and Pipe Works of Messrs. Wragge, at Swadlincote, near Burton-on-Trent. The exact locality is where the words "Round Wolds" occur half a mile east of Swadlincote, near bottom left-hand corner of Quarter-sheet No. 71 S.W. (Nottingham) of the One-inch Ordnance Survey. It is referred to on page 203 of Mr. H. B. Woodward's new work on "The Geology of England and Wales." It exhibits, in my opinion,

1. Four distinct systems or periods of strata, viz. Carboniferous, Permian, Trias, and Drift. Of the lowermost group of these rocks we have about 40 feet of Coal-measures, consisting of two thin coal-seams; four or five beds of fire-clay, three of which measure about 26 feet in the aggregate, and immediately below the Permians are variegated coal-shales with numerous nodules, and one or two bands of a variety of red hæmatite, and an occasional large concretionary mass of altered siliceo-ferruginous sandstone with cone-in-cone structure.[1]

The Permian strata appear to consist of dark red compact marl, some thin bands of tea-green marl, and a bed of semiconsolidated breccia, containing a variety of crystalline, slaty, igneous, and other rock-fragments.[2]

Upon these lie yellowish soft sandstones, flaggy beds, marls,

[1] See Geological Magazine, No. 1, p. 17, January, 1887.
[2] See Geological Magazine, Vol. for 1885, p. 333.

and a few quartz pebbles, and capping the whole is a rubble of sandstone fragments, layers of sand, a red marly clay with derived pebbles, and soil to surface.

The total thickness of strata at present exposed is about 70 feet, but other beds come in, and can still be seen, between the variegated Coal-measures and the Permians, about 300 feet further to the north.

Each of the above series lies unconformably upon the one beneath it; the Coal-measures have a north-easterly dip; the Permian beds dip east; the Trias lies nearly horizontal, and the Drift overlaps the whole, though it appears only locally.

SECTION AT SWADLINCOTE, DERBYSHIRE.

		Ft.	In.
Drift	Surface soil	1	0
	Red clay, sand, and fragments of sandstone	3	0
Trias	Green and red marly layers	1	0
	Soft sandstone, with layers of yellow and red marl	3	0
	Yellow sandstone, with a few quartzite pebbles at base	9	0
Permian	Light yellow sandstone	2	0
	Semiconsolidated breccia (sometimes in two beds)	4	0
	Red marl, with greenish layers top and bottom	3	6
Coal-measures	Highly-variegated argillaceous shale[1] with band and many flat fossiliferous nodules of red hæmatite, and a few large concretions of yellow and red siliceo-ferruginous sandstone, exhibiting cone-in-cone structure, etc.	8	0
	Dark blue shale without nodules, but sometimes with red veins or joints	3	0
	Coal-seam—sometimes iridescent		10
	Dark fire-clay	2	6
	Lighter ditto—locally called "the marl"	7	6
	Dark clay		6
	Strong grey blocky fire-clay—"the fire-clay"	8	0
	Hard dark shaly clay	1	2
	Coal-seam	1	3
	Inferior fire-clay	3	0
	Hard black clay		3
	Strong inferior fire-clay with nodular clay-ironstone much wrinkled on surfaces	8	6
	Floor of quarry[2]	71	0

Now, the principal point of interest in the above section is the uppermost bed of the Coal-measures—the 'bind' or argillaceous shale with its accompanying concretionary ironstones and large balls of altered 'cankstone.' Where this stratum is in contact with the red beds of the newer rocks, its colour becomes entirely changed, and the great variety of hues of red, brown, purple, yellow, blue, etc., together with the often very curious and remarkably beautiful way in which the alternations, blendings and arrangements of form have been produced, is in itself quite a study. The ironstones, too, certainly deserve attention. When the shale is variegated or mottled,

[1] Owing to unconformity the thickness of this stratum varies a good deal, and in places where the distance between the Permian marl and it, is much increased, the ironstone nodules are found in their natural condition (clay-carbonates).

[2] The section not having been carefully measured, the thicknesses here given are only approximate.

these are invariably found to be of a red hæmatite, more or less compact, and with the nuclei often of limonite more or less soft. These nodules of hæmatite were originally clay-ironstone before the Coal-measures were overlaid by the Permian beds. Of this I entertain no doubt, and in this very quarry may be seen the same nodules in their former condition. That these nodules in their normal state have a peculiar chemical composition not possessed by ordinary sphærosiderite of the Coal-measures seems highly probably from the fact that in weathering they sometimes become a deep red colour, and at others quite yellow. This alteration is always accompanied by a softening of the nodule, with reduction in weight.

At a few yards to the south of the section given above, we find the red-staining from the Permian marl has extended to the Fireclays beneath the 10-inch bed of Coal, giving them a somewhat similar variegated aspect (though the colouring is less vivid) to the shales above. The red hæmatitic character of the ferruginous nodules occurring in these clays shows also the change they have undergone since Carboniferous times.

In this section too may be seen instances of faulting. We have a dislocation caused *since* the Triassic beds were deposited (where good examples of *slickensides* occur); also one in these beds but not descending to the Coal-measures—a small 'doubling' or overlap fault in the Permian marls, and contorted denuded surface of Coal-measures. The Coal-measures are highly inclined. It may be well here to note that some interesting examples of contorted coal and of 'overlap' faults are to be seen in the neighbouring open-hole workings to the south, notably in those of Messrs. Ensor & Co., The Pool Works, Woodville.

Varieties of Coal-measure clays, and of the other clay-ironstone nodules, of 'peacock,' or iridescent coal, and of Coal-measure fossils (marine? mollusca, coprolites, etc.), may also be obtained: in short, the section exposed probably exhibits as great a number and variety of geological and mineralogical details as could be found anywhere within so limited an area.

There are within half a mile or so of this exposure several other interesting sections of some of the same beds, and of others besides, which could scarcely fail to repay a visit; but, as the excavations go on rapidly, and with strata lying so unconformable as these do, the geological details are always changing; in fact the variegated shale with hæmatite in Wragge's section is rapidly thinning out, or else being obliterated by debris thrown back, or by land-slips.

VII.—Palæontological Nomenclature.

By S. S. Buckman, F.G.S.

THE remarks made by Mr. Haddow in the Geological Magazine, Decade III. Vol. IV. p. 519, seem to demand a reply.

1.—He complains of the multiplication of generic or subgeneric names of *Ammonites*.

2.—He laments the confusion which appears to have arisen concerning what have hitherto been regarded as recognizable species.

3.—He suggests that the trinomial system would obviate the necessity of any of these changes and be at the same time an advantage.

In regard to the first point, I would remark that probably no change of any kind, however necessary, can be made without disturbing those who have been accustomed to other ways, and therefore, it is right that those who make these changes should give some reason for so doing. It can be urged that scarcely has the sound of the protests raised against the subdivision of the genus *Ammonites* died away, but the proposal to still further subdivide the subdivisions is started, and everything is again unsettled. But I would ask if palæontology is to follow, and be subject to, the same laws and conditions which govern other sciences, viz. entomology, botany, etc.? Is a genus to be considered as a name for a series of species having certain characteristics in common which at the same time separate it from other series? Is it not wrong to include in the same genus species descended for a long time through entirely different lines of ancestors? But do the present generic names satisfy these conditions? Does *Harpoceras*, which included such very different *Ammonites* as *bifrons*, *insignis* and *Levesquei*, i.e. *Ammonites* descended from the old families *Arietes*, *Armati*, and *Natrices*, of the Lias, fulfil the conditions of a genus? It cannot; and, therefore, I contend that it is necessary that the range of a genus should be narrowed. I place in the same genus *Ammonites bifrons* and *Levisoni* which agree in being very evolute, in having an identical suture-line, and quadrangular whorls with furrows on each side of a solid carina, but differ from each other specifically by a persistent but slight difference in ribbing. On the other hand, I decline to put into that genus *Ammonites* which have sagittate whorls, a different suture-line, and a hollow carina. As regards the difficulty of remembering all these names, I would point out that this is no more than we meet with in other sciences, and any disadvantage in this way is fully compensated by the advantage that we obtain by expressing a definite idea regarding a certain number of species. The number of genera in other sciences gives us sufficient excuse. For instance, in the division *Geometers* of the *Lepidoptera* we find, in Britain, about 200 species divided into 17 families and 88 genera.

Concerning the second part of Mr. Haddow's letter, I do not consider myself to blame for the confusion of which he speaks. He asks whether the "well-known specific names cannot be applied in a sufficiently comprehensive way to include the forms which the older authorities recognized under the names *A. serpentinus*, *A. jurensis*, and *A. Sowerbyi*, respectively?" But who are the older authorities in this matter? Surely they are those who in the first place imposed these names on certain definite species which they figured, and are we to perpetuate a mistake because since then certain authors and collectors have entirely mistaken the identity of the fossils so named? Mr. Haddow supposes, I fancy, that the species which the later authors had in view are merely varieties of what the older authors

had named, and that now there is "a tendency to confine a species within narrower limits than heretofore." I contend, however, that this is not the fact, but rather that we are in possession of an increased number of new forms and an increased amount of knowledge concerning their affinities and differences, and most certainly it is not the fact with regard to the species which he quotes. *Am. serpentinus* is not only not the same species, but so far as I can judge, not even the same genus as *Am. falcifer*. The large Ammonite figured as *jurensis* by Dr. Wright is not only most certainly not Zieten's species, but is even characteristic of the *Opalinum*-zone. The name *Ammonites jurensis* has been the cause of some singular mistakes. I believe that it is an open secret that when Dr. Wright first visited the Dorset Inferior Oolite, and saw the large *Lytoceras* which I have since named *Lyt. confusum*, he mistook it for *Am. jurensis*, and therefore classed the Inferior Oolite there as Lias, considering it to be on the same horizon as the Gloucestershire Cephalopoda-bed. Is not this an instance of the harm that can be done by extending the scope of a specific name? As to *Am. Sowerbyi*, it is none too easy to exactly determine what may be the adult form of the small specimen figured by Sowerby; but nevertheless my experience is that the majority of *Ammonites* labelled *Sowerbyi* in our public collections have but little to do with that species. When I first began collecting *Ammonites*, I found that all spinous falciform *Ammonites* of the Inferior Oolite were considered to be either *Am. Sowerbyi*, if with large coarse spines, or *Am. variabilis*, if compressed and with less conspicuous spines, and in fact the unfortunate meaning of the latter name was an excuse for placing any falciform *Ammonites* to that species that could not well be located elsewhere. This was the method of "general geologists," and the species they so named had nothing at all to do with d'Orbigny's *Am. variabilis* and but little with *Am. Sowerbyi*. What was the result? The ideas about the sequence of the Inferior Oolite beds and their correlation with those elsewhere were extremely indefinite, merely owing to a lax determination of the *Ammonites*.

Now I come to the trinomial system. Again I ask why should palæontological nomenclature differ from that of all other sciences? Are we likely to get other sciences to change their now well-established nomenclature from the binomial to the trinomial system, and if not, why should palæontology desire to be peculiar? The binomial system has been used by it hitherto, and it would cause as much inconvenience to change to the trinomial system as it will to continue the binomial and without, I think, the same advantage. Quenstedt has used a trinomial and even a quadrinomial nomenclature, but in a haphazard way, and when we come to such a name as his *Ammonites angulatus compressus gigas*, it seems to me that we have done with both elegance and utility. A modified trinomial system is practically in general use for varieties, and may well continue so, as *Ludwigia Murchisonæ*, var. *obtusa*. But supposing that the name of a well-known *Ammonite* is to be used instead of the new generic names, I would ask Mr. Haddow to kindly arrange the following species under a trinomial system, viz.:—

Ludwigia Murchisonæ.
,, ,, var. *obtusa.*
,, *cornu.*

or,

Lioceras elegans.
,, *opalinum.*
,, ,, var. *comptum.*

If he wrote *Ammonites Murchisonæ, Am. Murchisonæ obtusus,* and *Am. Murchisonæ cornu,* he would place *Am. cornu* in the same rank as the variety of *Murchisonæ,* which would not meet the facts of the case. If he leaves it *Am. cornu,* he does not show its relationship to *Am. Murchisonæ,* as I do by employing the word *Ludwigia.* Then would he write *Am. elegans, Am. elegans opalinus,* and *Ammonites elegans opalinus comptus?* If so, I fancy the system would be a more cumbrous obstacle to a beginner than the employment of many generic names; but if he wrote *Am. elegans comptus,* he would not state the facts of the case, which are, that *comptus* is a variety of *opalinus,* not of *elegans.* Then, what rule would be followed with regard to choosing the *Ammonite* which should be the leading one of the group? Surely that which selected the oldest known member, the one from which probably the others had descended, because an older species could hardly be placed subordinate to a younger one, which would happen by any other method. Therefore we choose *elegans* to be the dominant name, instead of using the new generic name *Lioceras;* but supposing we find a *Lioceras* older than *Am. elegans,* and such a thing is not unlikely to happen, then we must again change the dominant name throughout the group.

As regards the obstacles to beginners that these names present, I would remark that to them these changes do not present the same difficulty as they do to one who has been accustomed to an older system, and then has to unlearn and learn again. The beginner, never having learnt an old system, does not find the new one more unfamiliar than the old. Besides which, the use of these generic names is intended to point out and emphasize the differences in *Ammonites* which are now passed over owing to their being grouped in such large numbers.

Finally, with regard to the zones; we have not reached perfection, and must effect changes of name as our knowledge increases. I, too, can point out a zone that is in danger, viz. the well-known *Sauzei*-zone, because it seems most probable that the *Am. Sauzei,* d'Orbigny, was previously figured as *Am. contractus,* Sowerby; but d'Orbigny's figure being so much more easily recognized, his name came into more general use.

VIII.—Notes upon Ice Action in High Latitudes.

By Professor J. W. Spencer, M.A., Ph.D., F.G.S.

THESE notes are intended as an appendix to "Notes on the Erosive Power of Glaciers, as seen in Norway" (*vide* this Magazine, Decade III. 1887, Vol. IV. No. 4, p. 167).

1. The object of my visit to Norway and the Alps was to leave

closet-geology in America, in order to make personal observations of the phenomena associated with modern glaciers, —for comparison with those in the region of our Great Lakes, often attributed to land-ice. My conclusions—that simple land glaciers are not great eroding agents—are greatly strengthened, not merely by the observations of many other geologists, but particularly by those of various explorers in high latitudes—some of which are given here.

2. Herr Payer [1] states that the snow-line in Franz Josef Land descends to within 1000 feet of the sea (this is lower than is known anywhere else in the Arctic regions), and that numerous glaciers discharge great quantities of icebergs into the sea. He says:—"However diligently I looked for them, I never saw unmistakable traces of grinding and polish of rocks by glacial action."

3. Lieutenant Lockwood [2] found in Central Grinnell Land a thick ice-cap extending for a distance of 70–90 miles or more, faced by an ice-wall of a nearly uniform height of 125–200 feet, irrespective of topographical inequalities. It was quite free from rock-*débris*, except in a valley confined by mountainous walls, thousands of feet high. Along its foot there was almost an absence of morainic ridges, and even where present these deposits were unimportant fragments. The general absence of rocks and dirt in the Arctic glaciers is commented on by General Greely, who observed them only in two or three glaciers. The glaciation about Lake Hazen was not recent. The snow-line in this high latitude of Central Grinnell Land is 3800 feet above the sea.

4. In Spitzbergen, with a lower snow-line, Baron Nordenskjöld [3] found striated rock-surfaces only below 1000 feet. The same holds good with regard to Labrador, where mountains rise 6000 feet, whilst the glaciation has not been observed above 1000–1600 feet (Dr. R. Bell).[4]

5. In the Antarctic regions, the officers of the "Challenger" [5] remarked the absence of *débris* in the icebergs seen; although Ross in his Antarctic voyage examined volcanic rocks upon some of them. These volcanic blocks are supposed to have come from valleys in the mountains.

6. Indeed, outside the valleys, explorers in high latitudes have not found the tools for great erosion in the margins of the ice-caps visited. The continental area of North America presents much lower and less abrupt prominences than the reliefs of Greenland, Grinnell Land, Spitzbergen, or Franz Josef Land. Overhanging mountains seem to be necessary to furnish tools to land glaciers, by which alone any abrasion can be accomplished, and these conditions belong only to the valleys of great mountain ranges.

7. However, there is one condition, under which glaciers when shod with graving tools ought to be great eroders,—namely, when

[1] "New Lands within the Arctic Circle," 1872–74, Payer.
[2] "Three Years of Arctic Service," 1881–84, Greely.
[3] See Geological Magazine, 1876.
[4] Hudson's Bay Expedition of 1884.
[5] Notes by a Naturalist of the "Challenger," 1879, Moseley.

the motion is much more rapid than the flow of land-ice, which is three feet a day or less, and corresponds to the experimental movement—shown by Herr Pfaff,—under which conditions, as seen in Norway, included stones commonly adhere by friction to the subjacent rocks, and cause the lower surfaces of the ice to be grooved. Extraordinarily rapid movement has been seen at Jacobshavn glacier in Greenland, where Prof. A. Helland[1] found that the velocity reached 40–60 feet a day. In Alaska, Lieut. Schwatka[2] and Prof. G. F. Wright[3] observed a movement of 40–70 feet a day. In these cases the glaciers are moving into the sea, and a new element of partial flotation or sliding, which does not belong to the glaciers on land, is here introduced. The great velocity of these glaciers is far beyond any known ability of ice to flow as a plastic body. Consequently one is led to conclude that under partial flotation stones may be held firmly as graving tools by glaciers.

8. The appeal to the former magnitude of ice-masses as accomplishing different results from those seen at present seems to be begging the question, for the action under a greater thickness would differ from that under a lesser, in amount rather than in kind, for increased pressure upon the ice—raising the temperature—increases its plasticity, as the general mass is not below freezing-point. Consequently it seems improbable that stones should be held firmly under the changed condition, for in addition to the increased plasticity, the friction between the stones in the ice, and the rock, is also increased by the greater weight of ice.

9. Over the vast area of action, the work of floating or sea-ice in some form, is enormous.

On the northern side of Hudson Straits Dr. John Rae,[4] who had very extensive Arctic experiences, found that snow, drifting over precipices into the sea, resulted in the formation of bergs 100 feet thick (filled with loose rock-*débris* of the coast), having the form of the shore where they were produced. Most of the bergs break loose and drift away to melt or become stranded elsewhere.

10. Greely describes the great momentum with which floebergs come together, and by their meeting, the ice is crushed and forced up into ridges 50 to 60 feet high.

11. One cannot carefully read the results of the last British Arctic Expedition of 1875-76, under Sir George Nares, without being impressed with the erosive power of drifting ice. Floebergs are pushed upon a shelving sea-bottom, until the ice has risen 20—60 feet, after their first stranding, in perhaps only 48—72 feet of water, although of gigantic weight. As the grounded floebergs are forced up the shelving sea-bottom, ridges of earth and stones are pushed up in front of them. Floebergs which have toppled over, thus showing their original bottoms, and also the pushed-up coast-ice, are found to be grooved and to contain angular stones with their exposed

[1] See Q.J.G.S. 1877.
[2] *N.Y. Times* Alaska Expedition, 1886.
[3] The Muir Glacier, Amer. Journ. Sci. 1887.
[4] Canadian Journ. Toronto, 1859.

surfaces scratched and polished. As the movement is greater than the possible velocity of glaciers, it is only natural to expect great erosive effects from stones held as graving tools, or wrenched out owing to the brittleness of the ice, under such great stress, or from loose materials roughly thrust forward by the pack.

12. These observations and those of Prof. Milne[1] in Newfoundland, and others upon the action of coast-ice, all confirm the correctness of the verdict given by many geologists, especially in Europe, who have had the opportunity of studying living glaciers, viz. that the potency of land-glaciers as great *eroding* geological agents is not proven, if indeed they operate at all in such a manner.

IX.—Tertiary Outliers on the North Downs.

By the Rev. A. Irving, B.Sc. (Lond.), B.A., F.G.S.

In "Nature," August 26, 1886, vol. xxxiv. p. 387, I ventured to draw a distinction between the outliers of unfossiliferous Tertiary sands found at high altitudes on the North Downs and the deposits containing casts of fossils of Pliocene age which are found in hollows in the Chalk at Lenham. Last summer I visited and examined, I believe, all the more important outliers of the former series, Mr. J. Hutchins French, F.G.S., having kindly conducted me to those at Headley and Chipstead; those at Netley were visited with other members of the Geologists' Association under the direction of the same gentleman. The conclusion at which I have arrived from the lithological evidence (and there seems to be no other available) is, that these sands are more probably of Bagshot age than of any other.[2]

There is a vast amount of reconstructed clay material capping these hills over many square miles, which, in colour and other characters, points to its original deposition as part of the Reading Beds, and in these unrolled Chalk flints are generally sparsely distributed. There are also a good many outliers of those beds mapped by the Survey on the higher parts of the North Downs.[3] But there appear to be no traces of London Clay or of the Middle Bagshot clays.

Of the unfossiliferous sands referred to, those exposed in the sand-pit in Chipstead Wood, and those seen in the pit on Netley Heath (where only one section occurs of undoubted Tertiary sands *in sitû*, clearly differentiated from the overlying "run-of-the-hill" of later

[1] See Geological Magazine, Dec. II. Vol. III. No. 7, p. 303, 1876.

[2] "Nature," Oct. 16, 1887, vol. xxxvi. p. 531.

[3] Surely these are the patches of "clay-with-flints" (*Argile à silex*) of W. Whitaker and the French and Belgian geologists.—H. W.—The clays referred to are quite distinguishable from the "clay-with-flints" of Mr. Whitaker and the Survey, if by that term is understood the insoluble residue frequently found on the surface of the Chalk, the calcareous constituents of the original rock having been dissolved away by carbonated atmospheric waters; a kind of deposit known to the French geologists as "argile à silex" or "terrain superficiel de la craie" (Memoir *Les Causes Actuelles en Géologie*, p. 306).—A. I.

date) are the *exact counterpart in every way of the Upper Bagshot Sands*, as these are seen in the interior of the district; *e.g.* about Sandhurst, in the Fox Hills, and at Aldershot. Of those at Headley I should speak with more reserve as to their being *Upper* Bagshot, although I saw no good grounds for denying that they might represent the more marginal facies of the beds of that group. There is rather more distinctness of bedding than usual, and the sands are rather less loamy, and more marked by colour-bands, as the result of subsequent infiltration. But this can be observed even in the highest beds of the Fox Hills in places, and elsewhere in the district.

Associated with these sands on the Chalk hills at Headley, and in the *débris* of the hill-slope, well-rounded flint pebbles are met with in great numbers; at Headley they constitute a large proportion of the drift-gravel, which overlies the sands. These pebbles are so different from those which occur *in the clays* on the Downs, and so closely resemble the bluish Bagshot pebbles of Bearwood, Easthampstead, St. Anne's Hill, Chertsey, Aldershot, etc., that it seems impossible to deny that they may belong to the same formation. Sarsens also are not infrequently met with.

So far as the evidence goes, we seem (though it is not very strong) to have better grounds for assigning these outlying sands to the Bagshot (and perhaps to the Upper Bagshot), than any which has yet been brought forward for assigning them on the one hand to the Reading Beds, and on the other to the Pliocene.[1]

Assuming that they are of Bagshot age, and taking their present altitudes (550 to 600 feet above O.D.) into account, we arrive at the interesting and important result, that this represents approximately the extent of the post-Eocene elevation of the North Downs above the sea; and the differences between these and the present altitudes of the same horizons in the interior of the Bagshot area (if they could be precisely identified) would represent the extent of accentuation which the Wealden axis has undergone since the Eocene period.

The extensive prevalence of the Reading Beds to the south points to a later date for the elevation of the Wealden axis than that marked by those beds; while the presence of the pebbles in great force seems to indicate that the Chalk over the Wealden area was subjected to the abrading action of the sea to a large extent before the Eocene period[2] came to an end (as is well known); and to such an extent was this carried on, that even the Lower Greensand was exposed to the action of denuding agencies, and furnished a great part of the materials of the Upper Bagshot, in which scattered glauconitic grains occur locally.

[1] See Mem. Geol. Survey, vol. iv.
[2] Exclusive of the Oligocene.

X.—On the Occurrence of a Glaucophane-bearing Rock in Anglesey.

By Prof. J. F. Blake, M.A., F.G.S.

THE occurrence of glaucophane has not, I believe, been previously noted in Great Britain, and as it is a mineral of some interest, my friend Mr. Teall has suggested that a separate notice of it should be given. It would otherwise be naturally described in the Report on the Microscopic Structure of Anglesey Rocks to be presented to the British Association at their forthcoming meeting.

The rock which contains the mineral in question has already, in a certain sense, been described by Prof. Bonney in the Quarterly Journal of the Geological Society, vol. xxxv. p. 308, in the following words :—

"XII. Quarry near Anglesey Monument.

"A foliated dense felted mass of a dull greenish, rather decidedly dichroic mineral (probably a species of chlorite), and of small greenish yellow epidote crystals, with a few angular fragments of quartz (?), and two or three scales of mica (? paragonite)."

This description shows that the specimen which afforded it was one in which the glaucophane had gone over into chlorite, which it very frequently is found to do. In fact, there are many exposures of rock around the Anglesey Monument and to the south of it, which obviously, from their mode of occurrence and their connection with each other, all belong to the same mass, and their minute structure is of the same type; but in most the colouring mineral is a chlorite, and only in some of the freshest exposures, or in particular spots, is the original glaucophane seen. Elsewhere, by identity of structure and mode of recurrence, we may still recognize portions of the same mass in which the mineral is ordinary hornblende.

These rocks have been hitherto taken to be identical with the dark schists of the district in which the prevailing mineral is chlorite, and only recently has Dr. Callaway, at the British Association, come round to consider some of them igneous.

The beautiful blue tint of the glaucophane gives a very rich aspect to the rock under the microscope, by which the long crystals of this mineral are seen enwrapping and felting over the short crystals of epidote. The rock is so very foliated, in such excessively fine lines, and these are so beautifully contorted, that I had much difficulty at first in recognizing it as igneous; and since, according to my experience, hornblende in Anglesey is limited to igneous rocks, I had great difficulty in believing this blue mineral could really be glaucophane, which is only a variety of hornblende. However, I showed it to M. Renard at the meeting of the British Association, and he thought it would probably be glaucophane, and I therefore had a transverse section cut, and that set the matter at rest.

Prof. Rosenbusch in his "Mikroskopische Physiographie," p. 471, gives the following as the characters of Glaucophane :—

"It occurs always in prismatic crystals, bounded by the faces of ∞ P (100) and occasionally with ∞ P $\breve{\infty}$ (010) or ∞ P $\bar{\infty}$ (100), but without terminal faces. The usual cleavage is parallel to the prism with the amphibole angle (124° 25′—124° 44′), and the blue colour in reflected light makes it easily recognizable. Besides the cleavage, there is a very characteristic splitting, in which it particularly resembles actinolite. Glaucophane in the amphibole group corresponds pretty nearly with jadeite amongst the pyroxenes. The angle of extinction as measured on the plane of symmetry is very small, 4°—6°. The pleochroism is particularly clear and fine —c = sky-blue to ultramarine, rarely blue-green; b = reddish violet to bluish violet; a = nearly colourless to golden green. S.G. = 3·0—3·1. Glaucophane appears to be entirely confined to the crystalline schists and phyllites. The paragenesis of glaucophane is the same as that of actinolite and common hornblende, it is associated with diallage, omphacite, garnet, epidote, mica, and rutile."

The characters are perfectly possessed by the mineral in the Anglesey rock. It occurs in narrow elongated prisms, which are generally twisted round the epidote grains, and run into each other; but in clear spaces, filled with quartz, some isolated narrow crystals appear, at least 8 times as long as broad, and appearing to die out like wedges at either end; in other words, they have no terminal faces. These prisms seen in polarized light without the analyzer are blue when their long axes are parallel to the principal, *i.e.* the short axis of the Nicol, and nearly colourless when perpendicular. In ordinary light these of course produce a lighter tint of blue. As the mineral passes over into chlorite, this blue changes into green, as it may be seen to do in a single slide. As the long axis of a hornblende or glaucophane crystal lies near to c, this blue is the characteristic one, and the colour seen in the perpendicular direction is a combination of the other two. When the prism is cut perpendicularly to its length, a rhombic section is seen. If the longer diameter of this rhombus, which corresponds to b, is placed parallel to the principal plane of the Nicol, the colour is dirty violet; and if the short one corresponding to a is so placed, the crystal becomes colourless. With regard to the angles of this rhombus, its very small size, ·004 in., in longer diagonal, and the uncertainty of the direction in which it may be cut, renders the observation not very close. But the acute angle in three distinct trials I estimated at 55°, 56°, and 55° 20′, giving a mean of 55° 27′, or for the obtuse angle 124° 33′, which is within the limits given by Rosenbusch. These are the usual forms, but in one case is seen a rhomboid whose obtuse angle was estimated at 125°, and which would therefore probably be obliquely cut, as shown also by one pair of sides being lengthened. and in this the acute angles are cut off by narrow planes making equal angles with the two sides. While therefore the rhombuses have their edges formed by 110, this shows the trace of the 010. I have not observed any crystal with the trace of 100. The lines of cleavage are parallel to the faces of the rhombus. With regard to the

extinctions, when the long prisms are seen, they are either so matted together that no direction of edge can be ascertained, or they float in quartz, and no good extinction can be observed; but the darkest phase makes a large angle of about 15°, with the length of the prism.

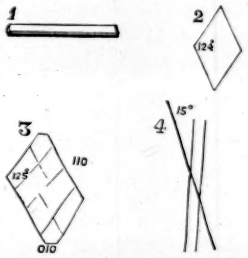

Fig. 1.—Prism of glaucophane seen perpendicular to the longer axis *c*.
Fig. 2.—End of the rhombic prism showing obtuse angle of 124°.
Fig. 3.—Prism (110) modified by planes of the pinacoid (010).
Fig. 4.—Showing plane of extinction making angle of 15° with the long axis of the prism.

These observations leave no doubt that the mineral is glaucophane. Its associates are epidote, rutile (?), quartz, felspar (?), and calcite. The epidote is very abundant in small highly polarizing grains, so that the rock is actually a glaucophane-epidote rock. As epidote is chiefly characterized by its lime, and glaucophane by its soda, we may suppose that the rock is essentially a diorite, in which there would normally be a soda-lime felspar and a hornblende; but that either at its formation under peculiar circumstances, or by later alterations, the soda combined with the hornblendic ingredients to produce the variety glaucophane, while the lime caused epidote to be substituted for felspar. The rock is singularly free from garnets, though one patch may be this mineral. There are also a number of small prismatic-looking specks of a rich brown colour, which are sometimes kneed, and which may possibly be rutile. These are the minerals essential to the rock; the others have been produced during the squeezings and stretchings to which it has been subject. Their interest lies in the fact that some of the crystals of glaucophane float freely in the clear crystalline substance, and the untorn substance does not look as if it could supply such crystals by tearing. It is thus suggested that the glaucophane *as such* may have been produced subsequently to the infiltration of the quartz.

I have to thank my friend Mr. Teall for suggestions relating to this matter, and for taking the trouble to verify the determination of the mineral.

NOTICES OF MEMOIRS.

I.—Glaciation of Salzach District.

Die Vergletscherung des Salzachgebietes nebst Beobachtungen über die Eiszeit in der Schweiz. von Dr. Eduard Brückner. Geographische Abhandlungen; herausgegeben von Dr. Albrecht Penck. Bd. 1. (Vienna, Hölder, 1887.)

DR. BRÜCKNER'S paper on the glaciation of the Salzach district furnishes us with another chapter in the history of the Glacial period on the northern slopes of the Alps. Whilst previous writers, such as Al. Favre and Falsan, have traced out the development of the Rhone glacier of the ice period, and Penck has worked at the glacial deposits between the Lake of Constance and the Chiem Lake, the present author has chosen the district of the Salzach, further to the eastward, as the field of his observations, and has in this memoir accumulated a great amount of detailed evidence on the extent of the glaciation, its effects on the configuration of the surface and its recurrence at distinct intervals. The results obtained agree with and confirm those of the authors above mentioned in the more westerly districts of the Alps.

One very noticeable fact is the decrease in the intensity of the glaciation in passing from the west towards the east. This is well shown by the author in a table in which a comparison is made between the level of the upper surface and the thickness of the more important Alpine glaciers at their points of issue from the mountains, together with the respective distances and the levels to which they extended from the foot of the mountains and the width of their outer morainic areas. Thus, for example, the upper surface of the ancient Rhone-glacier at the position indicated was 1500 mètres and its thickness 1300 mètres; it reached 170 kilom. from the mountains, and descended to a level of 300 m. The old Salzach glacier, on the other hand, was only 650 m. in thickness, and its upper surface 1050 m., whilst it only reached 32 kilom. from the mountains, and not lower than 500 m. The height of the snow-line in the Salzach district during the Glacial period is estimated at 1200 m.

The author points out the very distinctive character of the two zones of ancient moraines; an outer, distinct petrographically as well as by its having a covering of Loess or of a fine clay of a similar character, and an inner moraine which has a well-marked terminal wall, and is without a layer of Loess. The author has ascertained the extension of the inner moraine over the Loess as well as over the outer moraine, thus indicating its interglacial age, and he has further discovered no fewer than seven profiles in which the two moraines were clearly separated from each other, either by the Loess, or by important beds of gravel and conglomerate, thus showing an interglacial interval between their deposition. The high terrace gravels which occur beneath the outer moraine, and the lower terrace gravels deposited in advance of the inner second moraine, are well developed in the Salzach district, and the author further describes

a third series of widely-distributed gravels, which are believed to indicate a more extensive and an older advance of the glaciers.

The character and origin of the lakes not only of the Salzach district, but of the Linth and those of the Neuenburg group, are fully treated, and a special chapter is devoted to the Glacial deposits of the Lake of Geneva.

The text is accompanied by several figures and tables, as well as by three elaborate coloured maps of the district described.

II.—The Matrix of the Diamond. By Prof. Carvill Lewis.

(Abstract of a Paper read at the Manchester Meeting of the British Association, September, 1887.)

A MICROSCOPICAL study of the remarkable porphyritic peridotite which contains the diamonds in South Africa demonstrates several interesting and peculiar features.

The *olivine*, forming much the most abundant constituent, is in porphyritic crystals, sometimes well bounded by crystal faces, at other times rounded and with corrosive cavities, such as occur in it in basaltic rocks. It rarely encloses rounded grains of glassy bronzite, as has been observed in meteorites. The olivine alters either into serpentine in the ordinary way, or into an aggregate of acicular tremolite crystals, the so-called '*pilit*,' or becomes surrounded by a zone of indigo blue bastite—a new variety of that substance. The olivine is distinguished by an unusually good cleavage in two directions.

Bronzite, chrome diallage, and *smaragdite* occur in fine green plates, closely resembling one another. The bronzite is often surrounded by a remarkable zone, with a centric pegmatitic, or chondritic structure, such as occurs in certain meteorites. This zone is mainly composed of wormlike olivine grains, but a mineral having the optical characters of cyanite also occurs in this zone.

Biotite, a characteristic constituent, occurs in conspicuous plates, often twinned, generally rounded, and distinguished by its weak pleochroism, a character peculiar to the biotite of ultra-basic eruptive rocks. It alters by decomposition into the so-called *Vaalite*.

Perowskite occurs in very numerous but small crystals, which optically appear to be compound rhombic twins.

Pyrope is abundant in rounded red grains. Titanic iron, chromic iron, and some fifteen other minerals were also found. Rutile is formed as a secondary mineral through the alteration of olivine into serpentine, being a genesis of rutile not heretofore observed.

The *chemical composition* shows this to be one of the most basic rocks known, and is a composition which by calculation would belong to a rock composed of equal parts of olivine and serpentine, impregnated by calcite.

The *structure* is at the same time porphyritic and brecciated, being one characteristic of a volcanic rock which after becoming hard had been subjected to mechanical movements. It is a volcanic breccia, but not an ash or tuff, the peculiar structure being apparently due

to successive paroxysmal eruptions. A similar structure is known in *meteorites*, with which bodies this rock has several analogies. A large amount of the adjoining bituminous shale is enclosed, and has been more or less baked and altered. The occurrence of minute tourmalines is evidence of fumarole action.

The microscopical examination supports the geological data in testifying to the igneous and eruptive character of the peridotite, which lies in the neck or vent of an old volcano.

While belonging to the family of peridotites, this rock is quite distinct in structure and composition from any member of that group heretofore named. It is more basic than the picrite porphyrites, and is not holocrystalline like dunite or saxonite. It is clearly a new rock-type, worthy of a distinctive name. The name *Kimberlite*, from the famous locality where it was first observed, is therefore proposed.

Kimberlite probably occurs in several places in Europe, certain garnetiferous serpentines belonging here. It is already known at two places in the United States: at Elliott County, Kentucky, and at Syracuse, New York; at both of which places it is eruptive and Post-Carboniferous, similar in structure and composition to the Kimberley rock.

At the diamond localities in other parts of the world diamonds are found either in diluvial gravels or in conglomerates of secondary origin, and the original matrix is difficult to discover. Thus, in India and Brazil the diamonds lie in conglomerate with other pebbles, and their matrix has not been discovered. Recent observations in Brazil have proved that it is a mistake to suppose that diamonds occur in itacolumite, specimens supposed to show this association being artificially manufactured. But at other diamond localities, where the geology of the region is better known than in India or Brazil, the matrix of the diamond may be inferred with some degree of certainty. Thus, in Borneo, diamonds and platinum occur only in those rivers which drain a serpentine district, and on Tanah Laut they also lie on serpentine. In New South Wales, near each locality where diamonds occur, serpentine also occurs, and is sometimes in contact with Carboniferous shales. Platinum, also derived from eruptive serpentine, occurs here with the diamonds. In the Urals, diamonds have been reported from four widely separated localities, and at each of these, as shown on Murchison's map, serpentine occurs. At one of the localities the serpentine has been shown to be an altered peridotite. A diamond has been found in Bohemia in a sand containing pyropes, and these pyropes are now known to have been derived from a serpentine altered from a peridotite. In North Carolina a number of diamonds and some platinum have been found in river sands, and that State is distinguished from all others in eastern America by its great beds of peridotite and its abundant serpentine. Finally, in northern California, where diamonds occur plentifully and are associated with platinum, there are great outbursts of Post-Carboniferous eruptive serpentine, the serpentine being more abundant than elsewhere in North America. At all the localities mentioned chromic and

titanic iron ore occur in the diamond-bearing sand, and both of these minerals are characteristic constituents of serpentine.

All the facts thus far collected indicate *serpentine*, in the form of a decomposed eruptive peridotite, as the original matrix of the diamond.

III.—Permian Fossils from Spitzbergen.

Anmärkningar om Permfossil från Spetsbergen, af Bernhard Lundgren. Bihang till K. Svenska Vet. Akad. Handlingar. Bd. 13 (1887), Afd. iv. No. 1, pp. 3—26, t. 1.

THE fossils from Spitzbergen which by de Koninck[1] and Geinitz were accepted as proving the Permian character of the beds in which they occurred, were shown subsequently by Lindström to be associated with species which, in other localities, are distinctly characteristic of the true Carboniferous Limestone, and the Spitzbergen strata, in which this intermingling of Carboniferous and Permian fossils takes place, have therefore been termed the Permo-carbon series. In the Swedish expedition to this island in 1882, Nathorst and De Geer discovered in Belsund and Tcefjord a series of rocks, principally shales and sandstones, reaching a thickness of about 300 mètres, which rests upon the thick mass of cherty and siliceous rocks of the Permo-carbon series, and are overlaid by rocks with Trias fossils. A scanty fauna, entirely marine, was found in this sandstone and shale series, and is described in this paper by Prof. Lundgren. It consists principally of small Brachiopods and Lamellibranchs with a single Coral, *Stenopora columnaris*, Schlot. Some of these forms are identical with, and others are closely allied to, those in the Permian series of England, Germany, Petschora-land, and the North-west of North America. In these Spitzbergen rocks all the fossils are distinctly of a Permian type, and the Carboniferous Limestone forms have quite disappeared, thus showing a gradual extinction of these latter before the deposition of this series, which may justly be regarded as Permian. Prof. Lundgren figures the new forms, which are of a dwarfed character. G. J. H.

IV.—Preliminary Observations on the Geology of Wicklow and Wexford. By Professor Sollas, LL.D., F.G.S.

OF rocks older than the Cambrian examples probably occur in the Carnsore district, but most of the presumed Archæan rocks are to be explained as crushed igneous dykes and flows. The Cambrian are certainly unconformably succeeded by the Ordovician.

The main granite of the district is a truly intrusive rock; but at its junction with the Ordovician which it penetrates, it possesses the characters of a true gneiss, the schistosity of which corresponds in direction with that of the adjoining schists, having resulted from earth-movements which took place after the Ordovician and before the Lower Carboniferous period.

[1] Bull. de l'Acad. Royale de Belgique, ser. 1, vols. 13, 16.

REVIEWS.

I.—On the Structure and Classification of the Mesozoic Mammalia. By Dr. Henry F. Osborn. Proc. Acad. Nat. Sci. Philadelphia, June 21st, 1887.

THIS paper is an outline of Professor Osborn's observations "upon the structure of the British Mesozoic Mammals and a Classification of the Mesozoic Mammals in general, in view of their relationship to each other and to recent orders." The author, who is well known by his numerous palæontological and morphological researches conducted in the Princeton College laboratories, has had the opportunity of examining the type-specimens of all the Mesozoic Mammals hitherto described, except four. The results of so extended a study are thus of unusual interest and significance. After some preliminary remarks, a series of notes are offered upon the English fossils, described by Owen; and the succeeding larger section of the paper is occupied with a general scheme of classification.

Referring first to the Stonesfield Slate jaws, Dr. Osborn remarks that three distinct genera are commonly included under the name *Amphitherium*. The molar of *Amphitherium* proper (type *A. Prevostii*) is bicuspidate, with a low posterior heel; that of *Amphitylus*, gen. nov., has three blunt cusps and an internal cingulum; while that of *Amphilestes*, Owen (type *A. Broderipii*), has three prominent cusps, and a pronounced cingulum, encircling the crown. The lower dental formula of *Phascolotherium* is given as i. 4, c. 1, pm. 0, m. 7.

Triconodon is the first Purbeck genus remarked upon. Dr. Osborn points out that in this primitive form, the fourth premolar early replaces a molariform milk-tooth, and the fourth true molar is very late in rising, thus agreeing precisely with the mode of succession determined by Professor Flower in certain existing Marsupials. *Triacanthodon* consequently becomes a synonym of *Triconodon*. *Phascolestes* is considered to be quite distinct from *Peralestes*, and *Leptocladus* from *Stylodon*. *Spalacotherium* has the lower dental formula, i. ? 2, c. 1, pm. 4, m. 6. The maxilla referred by Owen to *Stylodon* must be removed to a distinct genus, *Kurtodon*,[1] characterized by the compact arrangement and peculiar wearing pattern of the crowns, and a new enlarged figure is given in illustration. The maxillary formula of *Bolodon* is found to be i. ? 2, c. 0, pm. 3, m. 4, and the characters of these teeth are also shown in a woodcut.

The following is a synopsis of the proposed classification:—

I. Multituberculata.—One incisor greatly developed at the expense of the others and of the canine; diastema, varying in width, in front of the premolars; molars characterized by two or more antero-posterior rows of tubercles separated by longitudinal valleys or grooves.

Fam. 1. Plagiaulacidæ. *Ctenacodon*, *Plagiaulax*, *Ptilodus*. (Also the Tertiary *Neoplagiaulax*.)
Fam. 2. Bolodontidæ. *Bolodon*, *Allodon*.
Fam. 3. Tritylodontidæ. *Tritylodon*.

[1] In the original paper, the preoccupied term *Athrodon* is employed. This is replaced by *Kurtodon* in the "Amer. Nat.," Nov. 1887, p. 1020.

II. Second Group.—Incisors numerous and sub-equal in size; canines large; usually no diastema; premolar-molar series usually in excess of the typical number; molars cusped rather than tubercular.

A. *Jurassic Mammals.*

(i.) *Carnivorous.* Canines large, erect,; molars with strong internal cingulum; premolars with basal cusps; condyle of mandible low, and coronoid process broad.

Fam. 1. Triconodontidæ. *Triconodon* (= *Triacanthodon* + *Priacodon*), *Amphilestes*. (?) *Amphitylus* and *Amphitherium*.
Fam. 2. Phascolotheridæ. *Tinodon*, *Phascolotherium*.
Fam. 3. Spalacotheridæ. *Menacodon*, *Spalacotherium*.

(ii.) *Omnivorous.* Lower canines large, erect; molars with more or less prominent internal row of low cusps; condyle usually on or below the molar level.

Fam. 4. Peralestidæ. *Peralestes*, *Peraspalax*.
Fam. 5. Paurodontidæ. *Paurodon*.
Fam. 6. Diplocynodontidæ. *Docodon*, *Diplocynodon*, *Enneodon*, (?) *Peramus*.

(iii.) *Insectivorous.* Incisors procumbent and spatulate; canines small; molars without cingulum; condyle high, coronoid process slender.

Fam. 7. Amblotheridæ. *Achyrodon*, *Amblotherium*.
Fam. 8. Stylodontidæ. *Stylodon* (= *Stylacodon*), *Aesthenodon*, *Laodon*, *Dryolestes*, *Phascolestes*.

(iv.) *Herbivorous.* Molars without cusps.

Fam. 9. Kurtodontidæ. *Kurtodon*.

B. *Triassic Mammals* (*Protodonta*, ? new order).

Fam. 10. Dromatheridæ. *Dromatherium*, *Microconodon*.

It is now generally admitted that many of the genera embraced in Cope's Multituberculata were Marsupials, and Dr. Osborn regards this group as most probably a suborder of the Marsupialia. The second group, however, is of a very different character, and Prof. Marsh has raised its Jurassic members to the rank of a new order [see Geol. Mag. July, 1887]. This arrangement presents some difficulties, and Dr. Osborn's concluding remarks are devoted to these as follows:—"It is impossible to find a single common character[1] or set of characters for these genera which is of ordinal value. On the other hand, there are many grounds for placing the *Triconodontidæ*, *Peralestidæ*, and *Kurtodontidæ*, and their affiliated families, in or near the ancestral lines of the modern *Dasyuridæ* and *Phascolomyidæ* respectively, while the *Stylodontidæ* are similarly related to the [Placental] *Chrysochloridæ*. These grounds may be partially stated. (1) *Triconodon* has one more premolar, but otherwise resembles *Thylacinus* both in the structure of the mandible and in the form and succession of the teeth. (2) *Peraspalax*, although much more imperfectly known, is allied to *Dasyurus* in its molar structure. (3) *Kurtodon*, although differing from *Phascolomys* in the possession of a large canine, shows a marked resemblance to this genus in the molar structure. . . . In the *Amblotheridæ* and *Stylodontidæ* we probably have a line of Insectivora. *Dryolestes* has

[1] The mylohyoid groove is universally present, but is also found in *Myrmecobius*.

a molar pattern which is not observed in any Marsupial, but is seen in *Chrysochloris* among the Insectivora. Since, however, it is common for Marsupials to mimic the dentition of other orders, this relationship must be held with some reserve." A. S. W.

II.—Department of Mines, New South Wales.

(1.) Annual Report of the Department of Mines, New South Wales, for year 1886. Sydney, 1887.

(2.) Geology of the Vegetable Creek Tin-Mining Field, New England District, New South Wales. By T. W. Edgeworth David, B.A., F.G.S. Department of Mines, Sydney, 1887.

THE annual report for the most part consists of details of the nature and amount of work carried on in the various mines of gold, silver, tin, copper, coal, and other minerals in different parts of the country, as well as of the character and prospects of the newly discovered mineral districts by the geological surveyors, under the direction of Mr. C. S. Wilkinson, F.G.S., the head of the Survey. Of more than local interest is a report on New South Wales Diamonds, by Thos. Davies, F.G.S., and Robt. Etheridge, jun., in which, amongst other things, they point out that the diamonds from this country, in their physical characters are more nearly allied to those of Brazil than of any other country; that they are of greater hardness, which is a disadvantage as regards the cost of cutting, but on the other hand they are extra brilliant. The diamonds occur in drift which may be loose and coarse, and in places passes into a compact conglomerate. This drift is due to fluviatile action at different geological periods. Thus there is no resemblance to the diamantiferous rock of the celebrated Kimberley mines of South Africa. Mention is made of the discovery of specimens of *Mastodonsaurus* in the Hawkesbury series at Cockatoo Island, and of a new species of univalve shell which is described by Mr. Robert Etheridge as *Tremanotus maideni*, thus belonging to a genus hitherto only known from the Silurian rocks of North America and Europe. The form described is from the Hawkesbury sandstone, but there is a possibility that it may have been contained in a boulder of an older date.

The volume on the Vegetable-Creek Tin-mining Fields, by Mr. Edgeworth David, gives a detailed account of the geological structure of the district accompanied by maps and sections. The tin-stone is met with principally in gravels, some of which are of Post-Tertiary age, whilst others are beneath massive beds of basalt and other eruptive rocks. The source of the tin-stone has been traced to veins in granite which occurs plentifully in the district. G. J. H.

REPORTS AND PROCEEDINGS.

Geological Society of London.

I.—January 25, 1888.—Prof. J. W. Judd, F.R.S., President, in the Chair.—The following communications were read:—

1. "On *Ailurus anglicus*, a new Carnivore from the Red Crag." By Prof. W. Boyd Dawkins, M.A., F.R.S., F.G.S.

The specimen described is a small fragment of the right lower

jaw with the last three molar teeth in position, and belongs to the Crag collection of the Yorkshire Philosophical Society. It differs in a marked degree from all fossil European Carnivores, and presents no important points of difference when compared with a series of jaws of recent *Ailurus*. The author gave a description of the fossil and comparison of it with *Ailurus fulgens*, and also a table giving the comparative measurements of the teeth and jaws of the fossil and of recent *Ailuri*. The species from the Crag was a more powerful animal than any recent *Ailuri* in the British Museum. The paper concluded with a notice of the range of *Ailurus* in space and time.

2. "A Contribution to the Geology and Physical Geography of the Cape Colony." By Prof. A. H. Green, M.A., F.R.S., F.G.S.

The account given in this paper of the geology of Cape Colony was founded on observations made during a visit to the country of four months' duration for the purpose of reporting upon the coal. A considerable portion of the colony was traversed by the author, and, owing to the clear atmosphere and the barrenness of the surface, the rocks were unusually well seen. Much, too, had been ascertained by previous observers.

The grouping of the South-African rocks adopted was the following:—

9. Stormberg Beds { Volcanic Beds, 9 *d*. / Cave Sandstone, 9 *c*. / Red Beds, 9 *b*. / Molteno Beds, 9 *a*.
8. Karoo Beds.
7. Kimberley Shales.

Great Unconformity.

6. Ecca Beds.
5. Dwyka Conglomerate.

Unconformity.

4. Quartzite of the Zuurbergen, Zwartebergen, and Wittebergen.
3. Bokkeveldt Beds.
2. Table-Mountain Sandstone.

Great Unconformity.

1. Slates and intrusive Granite of the neighbourhood of Cape Town (Malmesbury Beds).

Of the four lowest subdivisions very little was seen. The Bokkeveldt Beds had yielded fossils referred to Devonian. The detailed descriptions commenced with the Dwyka Conglomerate, which was coarse, containing both rolled and angular fragments, the matrix, which was ill bedded, resembling granitic detritus. Some of the boulders suggested doubtfully the action of ice. The Ecca Beds consisted of hardened sandy clays, without lamination, and often weathering in spheroids, and resembling decomposed basalt or dolerite. These beds in the Ecca Pass, north-east of Grahamstown, were nearly 5000 feet thick.

The Kimberley Shales were mainly grey and dark sandy shales, with a few thin layers of argillaceous limestone. At their base a conglomerate, resembling the Dwyka Conglomerate, was sometimes found. The Karoo Beds were red and purple shales, with buff or reddish sandstone containing much decomposed felspar.

The Molteno Beds, also sandstones and shales, usually grey- and

dark-coloured, associated with grits and conglomerate, contained the only useful coals of the colony. These coals were peculiarly laminated and contained much ash; the seams were destitute of sandstones and often eroded on the upper surface. These characters might indicate subaqueous origin. Owing to the irregularity of the seams, the views generally formed of the coal-resources of the colony may be exaggerated. The upper subdivisions of the Stormberg Beds, the Red Beds, shales and sandstones of a red colour, the Cave Sandstone, a massive, fine-grained bed 150 feet thick, weathering white, and the bedded amygdaloidal lava-flows and tuffs that cap the whole, were but briefly noticed, as but few opportunities had offered for examining them.

Some petrological details were given of the contemporaneous and intrusive traps, all appearing to contain the same constituents as the overlying subaerial traps, and doubtless belonging to the same series of volcanic outbursts.

The author proceeded to review the lie of the rocks and physical structure of the country, distinguishing between the area of older rocks near the coast and the later deposits commencing with the Dwyka Conglomerate of the interior. There was apparently unconformity at the base of this conglomerate; it and the overlying Ecca Beds were thrown into folds and occupied the Karoo Plains, whilst the ranges to the northward were formed of the higher beds, all nearly horizontal and resting quite unconformably on the Ecca Beds. These ranges had been carved out by denudation, which had removed the Molteno, Karoo, and Stormberg Beds to the south and north. The view advocated by Mr. Dunn that the Kimberley Beds north of the ranges represented the Ecca Beds to the south was discussed, and the author gave reasons for dissenting from it, and classing the Kimberley Beds as a higher subdivision.

Some notes on more recent formations, the conglomerates of Oliphant's River and superficial deposits, were followed by a summary of the author's conclusions as to the probable geological history of South Africa. The Bokkeveldt Beds are shown by their fossils to be marine, and possibly all the formations up to the Zuurberg Quartzite may be also marine. The Ecca Beds have yielded no fossils which would enable us to decide whether they are marine or freshwater; the Kimberley, Karoo, and Stormberg Beds are looked upon as lacustrine.

3. "On Two New Lepidotoid Ganoids from the early Mesozoic Deposits of Orange Free State, South Africa." By A. Smith Woodward, Esq., F.G.S.

Of the two species of fishes described in the present paper, one was founded on specimens of four individuals brought to England by Dr. H. Exton in 1883, together with the types of *Tritylodon* and *Rhytidosteus*, the other on two examples recently received from the same source. Both were from the Stormberg Beds of the Upper Karoo series.

After giving further details of the structure of both forms, and describing the head and opercular fold, appendicular skeleton and

scales in each, the author showed that one species must be referred to the genus *Semionotus*, and was most nearly allied to the American types referred by Sir P. Egerton to *Ischypterus*. For this species the name of *Semionotus capensis* was proposed.

The other species agreed in its characters with the Platysomidæ, and was especially allied to the genus *Tetragonolepis*; but the nearest ally of all was a fish from the Hawkesbury Beds of Australia, *Clithrolepis granulatus*. The name of *Clithrolepis Extoni* was proposed for the new South African species.

II.—February 8, 1888.—Prof. J. W. Judd, F.R.S., President, in the Chair.—The following communications were read:—

1. "On some Remains of *Squatina Cranei*, sp. nov., and the Mandible of *Belonostomus cinctus*, from the Chalk of Sussex, preserved in the Collection of Henry Willett, Esq., F.G.S., Brighton Museum." By A. Smith Woodward, Esq., F.G.S.

The remains referable to *Squatina* consist of a crushed skull, with the mandibular and hyoid arches, and an associated fragment of the pectoral fin with dermal tubercles. The fish was probably about 30 inches long. There are some difficulties in the way of interpretation, but the form and relative proportions of the cranium, etc., appear to be similar to those of the living representative of the genus. The dentition is not completely preserved; the teeth near the symphysis of the mandible are relatively high and slender, while the opposing teeth are small. The great relative size of the spinous dermal tubercles serves to distinguish it from species of *Squatina* already known. The anterior lower teeth are also more slender than in the existing *S. angelus*.

No specimen of *Belonostomus* has hitherto revealed the precise characters of the dentition or the relations of the hindermost bones. This deficiency is now supplied. The two rami occupy only one half the entire length of the jaw, the anterior half being formed by the elongated presymphysial bone, which is provided with a powerful prehensile dentition. The character of the teeth was described by the author: the large median teeth end abruptly at the posterior extremity of the presymphysial element, but the small lateral teeth are continued backwards upon the rami of the jaw, increasing in size and becoming relatively shorter. Further details were given, and the evidence shows that the original specimens described by Agassiz, as portions of the mandibular rami of *Belonostomus cinctus*, are really fragments of the presymphysial bone of this species. Some of the relations of *Belonostomus* and *Aspidorhynchus* were pointed out.

2. "On the History and Characters of the Genus *Septastræa*, D'Orbigny (1849), and the Identity of its Type Species with that of *Glyphastræa*, Duncan (1887)." By George Jennings Hinde, Ph.D., F.G.S.

D'Orbigny founded the genus *Septastræa* on the characters of a coral from the Miocene strata of Virginia, which was named *S. subramosa*, but no specific description was given. In the same year (1849), Edwards & Haime accepted the genus as valid, but placed

S. subramosa as a synonym of *Astræa ramosa*, Defrance—an apparently *recent* species of coral which had previously only been informally described by Defrance. They also included in the genus *S. Forbesi*, the original specimen of which was from the Miocene of Maryland, and at that time in the collection of the Geological Survey in London. Later on, in 1852, D'Orbigny claimed that *S. Forbesi* was but a synonym of his *S. subramosa*. There is good reason for regarding this as correct, but owing to the fact that D'Orbigny's name *subramosa* was merely nominal and without description, the later name of *S. Forbesi*, Edwards & Haime, must be allowed to stand for the type of the genus *Septastræa*.

In 1861 de Fromentel, and in 1867 Prof. Duncan, included in *Septastræa* several species of Jurassic and Liassic corals, which, however, have no generic relationship to the type form of the genus from the Miocene Tertiary.

In 1887 Prof. Duncan read a paper before the Geological Society, in which he adopted *Septastræa Forbesi*, E. & H., as the type of a new genus *Glyphastræa*, thus leaving in *Septastræa* those Liassic and Jurassic species placed therein by himself and de Fromentel. As this proceeding is contrary to recognized rules of nomenclature, the genus *Glyphastræa* will have to be abolished.

In the type form of *Septastræa*, now in the British Natural-History Museum, the walls of the corallites, though closely apposed, are quite distinct; the theca is formed by the extension of the septal laminæ; the walls and septa in the lower portion of the corallites are very thin, but the upper portion of the corallites are so infilled with compact stereoplasm that the calices are extremely shallow when mature. There is no true columella, only a pseudo-columella, formed by the union and partial involution of the inner septal margins. The increase is inclusively by marginal gemmation; fission does not occur. In some cases linear perforations between the septa are shown; these appear to be for the insertion of the mesenterial muscles.

Tha septa in *Septastræa* consist of a central layer, dark in microscopic sections, the primary layer of v. Koch or centre of calcification of Bourne and Fowler, enclosed on both sides by layers of compact subcrystalline stereoplasm. In longitudinal fractures the septa frequently split in the centre of the dark or primary layer, and thus show that each half of the septum consists of a dark and light portion, and the median face of each septal lamina exhibits transverse growth-lines, not unlike those of an epitheca, beneath which are delicate longitudinal ridges and grooves. The thecal wall has a similar structure to that of the septal laminæ, of which it is an extension.

There is a close correspondence in the septal and thecal structure of *Septastræa* to that of the recent and fossil genus *Flabellum*, and in this genus also the septa occasionally split longitudinally and show the same growth-lines on their median faces.

Only two species are included in *Septastræa*, as now defined, viz. *S. Forbesi*, E. & H., and *S.* (*Columnaria*?) *sexradiata*, Lonsdale, sp.

3. "On the Examination of Insoluble Residues obtained from the Carboniferous Limestone at Clifton." By E. Wethered, Esq., F.G.S.

The author noticed previous classifications of the Carboniferous Limestone at Clifton, and submitted the following for reference in the present paper:—

CARBONIFEROUS LIMESTONE SERIES.

			feet
Stage C.	Upper Limestones		100
,, B.	Middle Limestones		1620
,, A.	Lower Limestones:—		
	1. Black Rock	490	
	2. Lower-Limestone Shales	500	
			990
	Total		2710

The limestone-forming organisms in each of the above were mentioned, and the methods adopted for obtaining the insoluble residues by means of hydrochloric acid were described. A table of percentages of insoluble residues was given from the Lower Limestone Shales and Black Rock, from the Oolitic Beds, *Mitcheldeania*-beds, and main portion of the Middle Limestones, and from the Upper Limestones.

Detrital quartz of small size, with a few grains of felspar, tourmaline, and zircon, characterize the Lower-Limestone Shales, and in one variety the soft tissues of organisms are represented by ferric oxide, which in the case of crinoids represents the whole skeleton. Residues of the Black Rock exhibit slight secondary crystallization round detrital quartz, whilst amorphous and chalcedonic silica become more plentiful. Residues of the Middle Limestone consist to a less extent of detrital quartz along with micro-crystals of quartz, amorphous and chalcedonic silica, and less frequently of pyrites, tourmaline, and zircon; sponge-spicules are also noted. Towards the top of the Middle Limestones the proportion of detrital quartz increases, and the deposit of secondary silica on the surface of quartz-grains is less marked.

The nature of the amorphous and chalcedonic silica in the limestone, and the relations of this silica to the small quartz-crystals, were also discussed. The latter were shown in some instances to possess nuclei of detrital quartz, and where this is not the case, to have resulted from the crystallization of amorphous silica.

GEOLOGISTS' ASSOCIATION.

December 2nd, 1887.—F. W. Rudler, Esq., F.G.S., President, in the Chair.—The following communication was read:—

"A Synopsis of the Vertebrate Fossils of the English Chalk," by A. Smith Woodward, F.G.S., F.Z.S.

The author reviewed in succession the various genera of fossil vertebrata hitherto recorded from the English Chalk, adding full references to the literature of the subject, British and Foreign. A careful examination of the type-specimens and numerous other fossils in the British Museum, Brighton Museum (Willett Collection),

Woodwardian Museum, the Museum of Practical Geology, and the private cabinets of Mr. S. J. Hawkins, F.G.S., and other members of the Association, had suggested several emendations in the already accepted nomenclature of the genera and species, besides adding a few new forms, either now described, or deferred for description to a future occasion. The revised list is as follows, with synonyms in brackets :—

Reptilia.

Order Chelonia.

(?) *Chelone Hoffmanni.* [*Chelone Camperi*, Owen.]

Cimoliochelys Benstedi (Mantell), Owen. [*Emys Benstedi*, Mantell.]

Order Sauropterygia.

Polyptychodon continuus, Owen.

,, *interruptus*, Owen.

Plesiosaurus Bernardi, Owen.

,, *constrictus*, Owen.

,, *Smithii*, Owen.

Order Ichthyosauria.

Ichthyosaurus campylodon, Carter.

Order Pythonomorpha.

Mosasaurus anceps (Owen). [*Leiodon anceps*, Owen. *Mosasaurus stenodon*, Charlesworth.]

Order Lacertilia.

Dolichosaurus longicollis, Owen.

Coniosaurus crassidens, Owen.

Rhaphiosaurus subulidens, Owen. [*R. lucius*, Owen.]

Order Plesiosauria.

Ornithocheirus giganteus (Bowerbank). [*Pterodactylus giganteus*, Bow., *Cimoliornis diomedeus*, Owen, *Pterodactylus conirostris*, Owen.]

,, *Cuvieri* (Bowerb.) [*Pterodactylus Cuvieri*, Bowerb.]

,, *compressirostris* (Owen). [*Pter. compressirostris*, Owen.]

Pisces.

Order Selachii.

Acrodus (?) *Illingworthi*, Dixon. [? *Hybodus.*]

Corax falcatus, Agass. [*Corax maximus*, Dixon.]

,, *pristodontus*, Agass.

Drepanephorus major (Agass.), Egert. [*Spinax major*, Agass., *Cestracion canaliculatus*, Egert., *Drepanephorus canaliculatus*, Egert., *Acrodus cretaceus*, Dixon, (?) *Acrodus rugosus*, Agass.]

Hybodus dubrisiensis, Mackie.

Notidanus microdon, Agass.

,, *pectinatus*, Agass.

Odontaspis rhaphiodon, Agass.

,, *subulata*, Agass.

Otodus appendiculatus, Agass.

,, *crassus*, Agass.

,, *semiplicatus*, Münster.

Oxyrhina crassidens, Dixon.

,, *Mantelli*, Agass. [*Lamna acuminata*, Agass.]

Ptychodus decurrens, Agass. [*Ptych. depressus*, Dixon.]

,, *latissimus*, Agass. [*Ptych. paucisulcatus*, Dixon.]

,, *mammillaris*, Agass. [*Ptych. altior*, Agass.]

,, *Oweni*, Dixon.

,, *polygyrus*, Agass. [*Aulodus Agassizii*, Dixon, *Ptych. latissimus*, Agass. in part.]

,, *rugosus*, Dixon. [*Ptych. altior*, Dixon, *non* Agass.]

Scylliodus antiquus, Agass.

Squatina Cranei, A. S. Woodw.

Order CHIMÆROIDEI.

Edaphodon Agassizii, Buckl.
,, *crassus*, Newton.
,, *gigas*, Egert.
,, *Mantellii*, Buckl.
,, *Sedgwickii*, Agass.
Elasmodectes Willetti, Newton. [*Elasmognathus*, Newton *non* Gray.]
Ischyodus brevirostris, Agass. (var.)
,, *incisus*, Newton.

Order GANOIDEI.

Belonostomus attenuatus, Dixon.
,, *cinctus*, Agass.
Cœlodus angustus (Agass.), Zittel. [*Gyrodus angustus*, Agass.]
,, *cretaceus* (Agass.), Zittel. [*Pycnodus cretaceus*, Agass.]
,, (?) *faba* (Agass.), Zittel. [*Acrotemnus faba*, Agass.]
,, *parallelus* ((Dixon), Zittel. [*Pycnodus parallelus*, Dixon.]
Gyrodus cretaceus, Agass. [*Gyrodus conicus*, Dixon.]
Lophiostomus Dixoni, Egert.
Macropoma Mantelli, Agass. [*Amia? lewesiensis*, Mantell.]
Microdon (?) *occipitalis*, Dixon.
Neorhombolepis excelsus, gen. et sp. nov.
Prionolepis angustus, Egert.
Gen. non det. [*Lepidotus punctatus*, Agass. MS.]

Order TELEOSTEI.

Acrognathus boops, Agass.
Aulolepis typus, Agass.
Berycopsis elegans, Dixon.
Beryx radians, Agass.
,, (?) *microcephalus*, Agass.
Calamopleurus anglicus, Dixon.
Cimolichthys lewesiensis, Leidy. [*Saurodon Leanus*, Agass. *non* Hays.]
Cladocyclus lewesiensis, Agass.
Daptinus intermedius, Newton.
Dercetis elongatus, Agass.
Enchodus lewesiensis (Mantell), Agass. [*Esox lewesiensis*, Mantell, *Enchodus halocyon*, Agass.]
Homonotus dorsalis, Dixon.
Hoplopteryx lewesiensis (Mantell). [*Zeus lewesiensis*, Mantell, *Beryx ornatus*, Agass.]
,, *superbus* (Dixon). [*Beryx superbus*, Dixon.]
Ichthyodectes elegans, Newton.
,, *minor* (Dixon), Newton. [*Hypsodon minor*, Dixon.]
Osmeroides lewesiensis (Mantell), Agass. [*Salmo lewesiensis*, Mantell.]
,, (?) *crassus*, Dixon.
Pachyrhizodus basalis, Dixon.
,, *Gardneri* (Mason), W. Davies MS. [*Hypsodon lewesiensis*, Ag., in part, erroneously described and figured. *Acrodontosaurus Gardneri*, Mason.]
,, *gracilis* (Owen), W. Davies MS. [*Mosasaurus gracilis*, Owen.]
Platax nuchalis (Dixon), A. S. Woodw. [*Microdon nuchalis*, Dixon.]
Plethodus expansus, Dixon.
,, *oblongus*, Dixon.
Plinthophorus robustus, Günther.
Pomognathus eupterygius, Dixon.
Portheus Mantelli, Newton. [*Hypsodon lewesiensis*, Agass. in part.]
,, *Daviesii*, Newton.
,, sp. ind. [*Hypsodon lewesiensis*, Agass. in part.]
Protosphyræna ferox, Leidy. [*Saurocephalus lanciformis*, Agass., *non* Harlan. *Xiphias Dixoni*, Leidy. *Erisichthe Dixoni*, Cope.]
,, *minor* (Agass.), A. S. Woodw. [*Tetrapterus minor*, Agass.]
Saurocephalus (?) *striatus*, Agass.
Stenostoma pulchella, Dixon.
Stratodus anglicus, sp. nov.

Tomognathus mordax, Dixon.	[*Tom. leiodus*, Dixon.]
Elopine Clupeoid, gen. non det.	
INCERTÆ SEDIS.	
Cœlorhynchus cretaceus, Dixon.	
Ancistrodon, sp.	
Pelecopterus spectabilis (Agass.), Cope.	[*Ptychodus spectabilis*, Agass.]
,, *gibberulus* (Agass.), Cope.	[,, *gibberulus*, Agass.]
,, *arcuatus* (Agass.), Cope.	[,, *arcuatus*, Agass.]
,, (?) *articulatus* (Agass.), Cope.	[,, *articulatus*, Agass.]

The author also pointed out that the type specimen of *Strophodus asper*, Agass., is a fragment of a Crustacean; that the so-called *Orthagoriscus*-jaw (Dixon) is the dentary bone of a Chelonian; that *Selache Daviesii*, Hasse, is founded upon a vertebra of *Ptychodus*; and that the so-called premaxilla of *Enchodus* is really the palatine bone.

CORRESPONDENCE.

THE DIMETIAN OF ST. DAVIDS.

SIR,—The geology of St. Davids will, I fear, never be settled by petrological methods. Recognizing this, I based my interpretation of the so-called Dimetian principally upon the relation and disposition of the various groups of rocks composing the peninsula of St. Davids. The result of my examination was to lead me to believe that by no known system of faults and folds could the "Dimetian," if a pre-Cambrian body, have been placed in its present relations with the surrounding rocks. This is my main contention, and all the remaining arguments are subsidiary, and in value only relative. As I have already developed these views in detail in a paper just read before the Liverpool Geological Society, I need not further dwell upon them here.

It is very far from my intention of entering upon a controversy upon this question, most of all from a petrological standpoint. On a re-perusal of the literature on this subject, I find that Dr. Hicks formerly described as shales interbedded in the Dimetian what he now considers to be Diabase Dykes.

I may be quite wrong in my view that the veins in question are included Cambrian shales; but until I have an opportunity of re-examining the district, I am not prepared to admit his contention.

PARK CORNER, BLUNDELLSANDS,
11th January, 1888.

T. MELLARD READE.

THE EXTENT OF THE HEMPSTEAD BEDS, ETC.

SIR,—Writing in the Isle of Wight,[1] with no library available, I find I have overlooked a paper by Dr. E. P. Wilkins, F.G.S. As long ago as 1861 he recorded a section of Hempstead Beds in the Medina (see Proc. Geol. Assoc. vol. i. p. 194).

CLEMENT REID.

[1] GEOL. MAG. Nov. 1887.

MISCELLANEOUS

British Petrography.

It may interest our petrological readers to learn that the remaining portion of Mr. Teall's admirable "British Petrography" is in the press, and will shortly appear. The issue in monthly parts, as originally contemplated by Mr. Teall, had, in consequence of an unforeseen contingency, to be discontinued. The firm of publishers that had undertaken to bring out the work became involved in financial difficulties, and ultimately failed, placing Mr. Teall in the remarkable predicament of having to purchase a portion of his own book. We are happy to be able to state that the work is now in good hands, namely, those of Messrs. Bemrose & Son, and is only awaiting the completion of a few of the plates, before being given to the scientific world. We must congratulate the author on having brought to a favourable conclusion an undertaking as comprehensive in design as it is thorough in execution. The 200 pages which have already appeared, replete with accurate and minute description, well furnished with references to original sources and illustrated by plates of surpassing beauty, have been sufficient to place the book in the front rank of petrographical literature, among such classic compeers as Fouqué and Lévy's "Minéralogie Micrographie," Rosenbusch's "Physiographie der Mineralien und Gesteine," and Zirkel's "Lehrbuch der Petrographie."

OBITUARY.

FERDINAND V. HAYDEN.

Born September, 1829; Died 23rd December, 1887.

Dr. F. V. Hayden was born in Westfield, Mass., in 1829. He was a graduate of Oberlin College, Ohio, and received the degree of Doctor of Medicine from the Medical School of Albany, N.Y., in 1853. He was surgeon in the army during the civil war; and after it for seven years, he held the position of Professor of Mineralogy and Geology in the University of Pennsylvania.

But the larger part of his time, from 1853 to the close of 1878, an interval of twenty-six years, was spent in Rocky Mountain exploration, in which his special work was geological; and through his labours and the investigations of those associated with him, a wide extent of territory, until then little studied, was examined geologically and topographically. Coal-beds were found and a new coal-flora made known, new fossil Mammals, Reptilia, and Fishes, in great numbers, were collected and described, the stratigraphy and palæontology of the Cretaceous and Tertiary and the intermediate Laramie or Lignite beds were well investigated, and the Yellowstone Geyser region brought to notice and explored.

Dr. Hayden's personal work consisted in a general geological reconnaissance of the regions visited, the collection of fossils, which was the chief object of the earlier expeditions, and the supervision and direction of the surveying parties. He was the first to make known the facts as to the vast Tertiary lake-areas of the summit